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CONCERNING SUBMARINE CABLES.

WE are told by those supposed to be authorities on the subject, how impossible it is to account for some of the many causes which damage the insulation, or are answerable for the breaks to which submarine cables are so frequently subject, it being truly said of them that they appear to be in a perfectly healthy condition one day and are dead the next.

An American scientific writer, Lieut. Maury, informs his readers that "there is a river in the sea," and we can readily believe that if we are to accept as facts the many things that have been said and written to account for the numerous mishaps to which, as a rule, cables seem liable, there are stranger things at the bottom of the sea than were ever evolved from the elastic imaginations of the most imaginative minds; the truth being, that where no inspection can take place it is easy to make assertions.

The first Atlantic telegraph cable was selected not for its merits, but because well prepared specimens of it looked so pretty that people would be easily induced to put their money into the undertaking; that is a state of things which should no longer exist.

Our opinion has always been and still is, that strict supervision by competent persons is absolutely necessary to ensure success in the selection, manufacture and laying of submarine telegraph cables, and we have not hesitated to assert this opinion on every possible occasion; we revert to it again now because we find in the "Life of Sir William Siemens" statements bearing on the subject which surprised even us. For instance, at page 164 of that work, under the heading, "The Algerian Cable," we read:—"The first work of importance undertaken in the new factory was a contract with the French Government for the manufacture and laying of a submarine cable to form a communication with their colonies in Algeria. It was to be about 140 miles long, extending from Oran, a town on the Algerian coast, to Carthagena, in Spain, from whence land communications already existed with France. . . . The design of this cable was on a somewhat novel plan, so far as the outer covering was concerned, which consisted of a binding sheathing of thin brass or copper strips, overlapping each other, and put on the hemp covering under great pressure. . . . The construction of the cable took longer time than was anticipated; but Mr. Siemens worked day and night at the factory to get it finished, and it was embarked on the 10th of December, 1863, on board a French ship specially fitted for the purpose, and which was afterwards named the *Dix Décembre*, in honour of the day."

The following February letters were published in the *Times* to the effect that:—"The operation of laying the Carthagena and Oran cable was commenced from Oran on the 28th ult., and the operation of laying progressed to their entire satisfaction for about one-third of the way, when the cable suddenly broke in a place where the hemp appears to be unduly weakened by some chemical agency. The depth was 2,700 metres, and a recovery not attempted. Notwithstanding the accident, both the French and Spanish engineers entertain the highest opinion of the cable, and recommend the same for future adoption." . . . .

"The cable parted at a splice made at our manufactory during the shipment, and the hemp at this particular place on investigation was found discoloured and damaged by some chemical agency, as acid, which, by some unhappy accident, must have had access to the place while making the joint. In all other parts of the cable the hemp is in as good and unchanged a condition as ever." As this type of cable and the machinery employed in laying it has never again been adopted, it is fair to presume that the other engineers concerned did not entertain the same opinion as the French and Spaniards.

At page 167 we read as follows:—"On the 11th of November he wrote thus to Colonel Stewart:—You will doubtless have heard that I have been unsuccessful with the Oran and Carthagena cable. Upon the second attempt it was, indeed, quite successfully laid, and worked admirably for a few hours, when the cable broke, 10 miles from Carthagena, upon the edge of a precipice which descends almost perpendicularly from comparatively shallow water to 2,800 metres.

"I had given 25 per cent. slack in approaching the rising ground, which, according to the soundings (by the French Admiralty), rises gradually. The cable must have been for nearly a mile in free suspension, and a fluctuation in the strength of the currents caused it to give way.

"The French Government admit that the soundings were to blame, and that a cable is not practicable in such a locality; they have, therefore, determined to go from Algeria to Sicily, Corsica, and on to Nice, and to charge me with the manufacture of the surplus length, making use of as much of the old cable as I shall succeed to take up. I took some up which had been laid in January last, and which was quite unaltered. It had been at 2,400 metres depth."

From data in our possession, we conclude that the cable was badly designed for the work it was expected to perform, and the special machinery employed for its submersion totally unsuited for the purpose. No wonder breaks were so frequent, especially during the attempts to recover the cable. Had not all the circumstances been known in connection with this experiment, it is probable that the progress of submarine telegraphy might have been retarded, for at that time endeavours were being made to raise sufficient money to lay a specially designed cable from Ireland to Newfoundland, employing the ss. *Great Eastern* for the work.

At page 209, anent the Direct Atlantic Cable, we read: "She had laid about 500 or 600 miles when Dr. Werner Siemens, who was testing the cable from the shore at Ballinskelligs Bay, found that a very slight fault had passed overboard. Hitherto it had not been customary to stop operations for faults of so trifling a character, as being too unimportant to interfere with the proper working of cables."

On the next page, with regard to the same cable, we read: "The principle of eliminating even the smallest faults was rigidly adhered to, although the completion of the cable was much delayed thereby; but since it has been handed over to the proprietors it has proved to be one of the most satisfactory cables ever laid, and its rate of transmission is far superior to that of cables in which minute faults have been allowed to remain."

This to us is curious reading in the year 1889. With reference to the *French Atlantic Cable*, we read, at page 223:—"The order was given by the French Company in March, 1879. The manufacture of the cable was finished by June 18th . . . and the main cable was handed over to the proprietors in perfect working order on October 26th, 1879."

Here is a case in which 2,250 knots of cable were manufactured and shipped in the short space of about 14 weeks. It is not, therefore, surprising that the laying took about 18 weeks; the wonder to us being that it ever was in perfect working order.

ALTERNATE CURRENT MOTORS.

EIGHTEEN months ago Professor Galileo Ferraris, of Turin, discovered that a copper cylinder when suspended between two coils, was set in rotary motion by alternating currents of the same period, but of different phase when sent through these coils, which were placed at right angles to each other. The explanation given by the discoverer was, that the resultant field of the two currents revolved round the common centre line of the coils and, by means of eddy currents created in the copper cylinder, dragged the latter after it. This principle, says Mr. Kapp, has been practically developed by Mr. Nicola Tesla and others, and motors have been actually built in which a revolving field causes, by a kind of electro-magnetic drag, an armature to revolve and give off mechanical work. Mr. Kapp in the paper, of which we published an abstract last week, regretted that he was unable to place before the Institution of Civil Engineers details of the Tesla motor, as constructed by the Westinghouse Company. It is now ten months since Mr. Tesla read a paper "On a New System of Alternate Current Motors and Transformers" before the American Institute of Electrical Engineers,* and in this paper the principles involved in the construction of such motors was thoroughly explained. Unfortunately, no figures were published which could give us an idea of the practical value of this invention. We were anxious to know something definite as to the size, power and efficiency of these machines, and we have searched in vain for such data in the papers of Mr. Kapp and Mr. Tesla, nor have we heard as yet of any successful application of alternating current motors. We were in hopes that Prof. Ayrton would have given a clear account of the Tesla motor, "the only one existing in Great Britain or perhaps in Europe," which the Westinghouse Company sent to the Central Institution a few months ago, but all that we could gather from Prof. Ayrton's remarks at the Civil Engineers' meeting, was that this motor has been tested and gave 0·63 of a horse-power at 3,200 revolutions per minute, with 3,720 alternations. The efficiency was not ascertained, therefore we miss one of the most important points, whereby an opinion on the subject might be formed. Prof. Anthony, however, made tests with the same or a similar machine, which Prof. Ayrton quoted, and there we find that "with 6,400 alternations over one horse-power can be obtained at an efficiency of 62 per cent." In this case, again, we lack necessary data, namely, the speed, and energy consumed. We conclude that it was extremely difficult to measure the exact amount of electrical energy used by the motor which was tested at the Central Institution; assuming, however, that an efficiency of 60 per cent. can be obtained with 3,720 alternations, we think that a speed of 3,200 revolutions per minute renders such a motor impracticable for most industrial applications, for to reduce this to a reasonable speed would involve much gearing and its attendent loss of power, so that the resultant efficiency would in some cases not amount to 30 per cent. We also know that this alternating current motor requires two independent circuits for its function; furthermore, we learn from the remarks at the discussion of the American Institute, in May last, that the speed of the motor fell off when the load was increased. Mr. Tesla said "that this was due to the fact that the armature was designed to secure a considerable effort from the start. But if we make an armature which is only designed for synchronism, the speed will always be the same, no matter what the load; only there is a disadvantage that at the outset the rotary effort is so small that it is apt not to start."

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* See ELECTRICAL REVIEW for June 15th, 1888.

The weight of material used in a Tesla motor must be several times as much as that necessary for a continuous current motor to give the same output, rendering such machines very costly.

Thus it would appear that alternating current motors are still a long way off the ideal goal, in spite of the strenuous efforts on the part of some of the smartest people in the world, and we are inclined to think that the solution of the problem may yet have to be sought in an entirely different direction.

A CORRESPONDENT informs us that he has recently made an invention which he considers of the greatest value to the electrical trades, and that he will be glad to publicly give them the benefit of it. He finds that such articles as the cores of electro-magnets, bobbins, and, he believes, even wire, can be coated with enamel or similar vitreous substance, and that this acts as a splendid insulator and protection for the wire to be wound thereon. It can also be used for the inside coating of iron tubes for the carrying of underground wires, and he thinks that many of our readers will find this of the greatest value. It is not often that one comes across a philanthropist of this kind, so we feel all the more sorry when we have to confess that we have heard of metals being enamelled previous to this present year of grace, and therefore we fear that the electrical trades will not derive much benefit from our correspondent's benign offer.

ON Saturday evening last we had an opportunity of inspecting the station of the Sheffield Telephone Exchange and Electric Light Company, Limited. Our visit was made all the more interesting from the fact that the Mordey alternator and transformers were practically in operation for the first time. A jeweller's shop in which were some 60 or 70 incandescent lamps gave a fine opportunity for noticing the behaviour of the generating plant which ran admirably, not the sign of a flicker or diminution of light being observable. It is evident that the company has the nucleus of what should, and no doubt will, turn out an excellent business, and we were much gratified to see the workmanlike arrangements of the station, further particulars of which can be obtained in our other pages. The price of gas is as low as 2s. 1d. per 1,000 cubic feet in the town, but on the other hand fuel is much cheaper than in London.

WE think, with regard to the compact Morse instrument of Messrs. Siemens, that it is only fair to the memory of the late Mr. Herring to refer back to the REVIEW for December 15th, 1878. In this number was described an instrument for producing practically the same results, *i.e.*, vertical instead of horizontal printing. Mr. Herring's apparatus never came into use, and it yet remains to be seen whether the telegraphists of to-day hold different opinions upon this improvement to those which were in vogue at the time when Mr. Herring strove so doggedly to show that his printer was superior to those universally employed then and now. His invention caused much controversy at the time, but practical operators showed very plainly that bad spacing and not imperfect dots and dashes caused most trouble and produced by far the largest number of mistakes. It is evident that the instrument described by Messrs. Siemens is more practical in its working parts than that of Herring, but the object sought is precisely the same.

MUCH as has been done in this country by the telephone companies, their achievements will not compare with the widespread and steadily increasing development of the telephone on the Continent. It is announced that telephone communication between Berlin and other towns in Germany is being rapidly established, and it is also stated that for some time past wires for this purpose have been in operation between newspaper editors at Berlin and their correspondents at Hamburg, Dresden, and other places. Between Paris and Brussels, too, very efficient telephonic communication exists. With these arrangements there is nothing to compare at present in this country, although there are a few fairly long-distance services. Between London and Brighton there is direct speaking connection, and there are a few similar instances in the North of England, but extensions of this kind are spreading very slowly. Yet there is on all hands a great demand for such facilities between towns 50 miles and further apart. Of this the port of Whitby affords an excellent example. This is admittedly an old-fashioned place in many respects, but it is still an important seaport, and in all that affects shipping it is wide-awake and enterprising. The greater portion of its trade is with South Wales, and some time ago the merchants and shipowners, having to some extent enjoyed the benefits of telephones in the town, initiated a movement for establishing direct telephonic communication, not only with comparatively near towns, such as Darlington and Sunderland, but actually with Cardiff. They fully expect to realise this scheme, and also to be brought within speaking range of all the principal commercial centres in England, and likewise of Glasgow, Edinburgh, and even Dundee and Aberdeen. It is only a question of time, but the telephone companies will be wise not to let that time be too long.

DEMONSTRATIONS by Col. Gouraud with the Edison phonograph will form one of the most interesting incidents at the *conversazione* which the Lord Mayor and Lady Mayoress will give at the Mansion House on Saturday evening in connection with the inauguration of the Institute of Journalists. In view of the possible but improbable suggestion that in time the phonograph may be used for recording speeches in Parliament and at public meetings, this instrument has a special interest for journalists at large, and more especially for those who are responsible for reporting speeches at Westminster and elsewhere.

IT will be observed from the paper published further on that Prof. Jamieson's notions on the subject of dynamo designing are of a somewhat crude character. The Prof. employs some antiquated formulæ published by Kapp four years ago, where the resistance of the magnetic circuit is expressed in terms of dimensions only, without reference to the degree of saturation at which the circuit is worked. About three years ago Kapp modified these formulæ by introducing a tangent function which was supposed to take account of and allow for the saturation, but this very necessary modification Prof. Jamieson for some reason ignores, and we have in consequence a paper which represents fairly the state of dynamo science four years ago. That empirical formulæ of any kind are still used for dynamo calculations is surely surprising, when the actual facts of magnetisation, as determined by the most careful of experimenters, are so easily attainable.

BUT even the simple formulæ he employs the author of the paper applies wrongly. To find the exciting power for the machine, he adds all the magnetic resistances of the component parts, and multiplies by the lines through the magnet, which is incorrect. In order to find the exciting power for the armature its magnetic resistance ought to be multipled by the lines through it, which are, according to Jamieson, 20 per cent. under those through the magnets. The power for the air space and magnets can be found by multiplying the sum of their resistances by the lines through them, and the two exciting powers thus found make up that of the complete machine. Prof. Jamieson neglects the effect of the current in the armature, which is very important; indeed, the paper does not give the least idea of scientific designing.

THE precise object the professor had in view in sending such a paper to the Institution of Engineers and Shipbuilders it is difficult to imagine. Was it to teach the shipbuilders to design their dynamos? In that case it may be assumed that the author failed in much the same way as Mr. Kapp did in trying to teach the Institution of Civil Engineers how to design alternating current machinery. We have grave doubts as to whether in either assembly 10 per cent. of the members outside those specially invited as experts would know how to join up the conductors of a ring or drum armature to the collector plates. Whoever designs dynamos must be properly instructed in the work by competent teachers, and it is absurd to deal with the subject of dynamo design to a number of men who are quite unable to comprehend a tenth part of what is being told them. Surely a paper given to an assembly of engineers and shipbuilders ought to be restricted to the most elementary principles, without being encumbered by formulæ which, to start with, happen to be all wrong!

ON Tuesday the discussion on Mr. Kapp's paper, at the Institution of Civil Engineers, was brought to a close. A look of bewilderment was visible on the faces of most of the members as they listened to the wonderful talk of harmonic curves, sine functions, Fourier's series, hysteresis, and electrical resonators. In the mazes of Blakesley's diagram they may have been said to have completely lost themselves. By-the-way, Mr. Blakesley made a very funny remark to the effect that engineers should make all their machines give sine curves, if they did not do so already, because then *all the different relations in the machine could be represented graphically by his diagrams!!!* It would appear as if machines were built to give sine curves instead of light and power.

MR. KAPP replied with warmth to some of Mr. Blakesley's criticisms, and made several good hits. This passage of arms shows once more that the theorist generally misses the point of the practical man, and is ever liable to attribute importance to matters which the latter considers as of no moment.

PROF. GEORGE FORBES considers that it is highly necessary in electrical distribution to have feeders supplying the mains even though the distance exceeds several miles. There is, he says, a general impression in this country that such a course is not necessary, but here the experience of other countries has been set at defiance. If such views continue to be adopted, says Prof. Forbes, the result will be as disastrous in the future as it has been in the past. At the present moment the learned Professor thinks that the only types of underground cables suitable for permanent work are either bare copper supported on insulators, or else vulcanised India-rubber, or perhaps okonite. This expression of opinion from such an authority on insulated wires, is sure to bring forth protests from the manufacturers of those wares which he does not look upon with a kindly eye. Touching converters, Mr. Forbes would be much surprised if there are more than two types in use in this country which have an efficiency for an average number of lamps over 70 per cent. We agree with him, and have held that opinion from the time we criticised Dr. Hopkinson's tests of the Gaulard and Gibbs apparatus when used some time ago on the Metropolitan Railway. The efficiency of a converter falls when underloaded, and this defect is clearly shown in the load diagram of the Grosvenor Gallery installation. The waste in a converter, independent of magnetic friction, as shown by Prof. Forbes's formulæ, varies as the square of the magnetic resistance. High magnetic resistance converters require a great deal of copper, and the magnetic friction is so great that they would probably work better with an open magnetic circuit, as shown by Lord Rayleigh.

JABLOCHKOFF'S patent of 1877 is now recognised as covering the system of electrical distribution by transformers. The United Electrical Engineering Company, Limited, holds this, and arrangements have been concluded involving both the recognition and support of the patent with the leading electric lighting companies. The name of Paul Jablochkoff has been long and honourably known in connection with the development of the electrical industry, for at an early period he was identified with what was then termed the "division of the electric light." It has, of course, been a question open to argument whether Jablochkoff's claims are restricted to a peculiar kind of apparatus connected up in series, but, in the opinion of two of the most eminent counsel in patent matters, he did not limit himself to series working, his claim including any arrangement of secondary generators in parallel or series. To us, however, it has always been a mystery why a claim should ever have been allowed in electric lighting matters for a method of connecting up which everybody used in other branches of electrical work if they thought fit. By this we mean if a circuit contained instruments of any description which did not give the expected results—say, in series—they were simply joined up in parallel for the purpose of ascertaining if that were the preferable mode of connection. We have dealt with this topic to some extent in another article on the Gaulard and Gibbs appeal case.

SIEMENS'S RECORDING APPARATUS FOR COMPACT MORSE WRITING (PATENT).

THE alphabet formed by the combination of two elementary signs, the "dot" and the "dash," which is used in Morse telegraph instruments of the recording type, is almost universally written in a single longitudinal line on the paper strip.

This method of writing, however, possesses the great disadvantage that the diameter of the writing disc cannot be made very small, as it would not then be certain to dip into the ink contained in the trough. A disc of comparatively large diameter, although clean in its working, is unsuitable for producing a short and sharp sign on the paper strip, particularly when the strip is moving slowly, as the tangential contact between the writing disc and the paper produces an unnecessarily long sign with a large disc, and hence the tendency to "tailing" is increased. It is for these reasons that the "dots" of the Morse alphabet can in general practice only be produced as short dashes, so that, in order to prevent misapprehension, the "dashes" require to be made longer than would be necessary if distinct dots could be produced. The writing is thus spread over far more paper than is desirable, causing not only a waste of paper but making the reading more difficult.

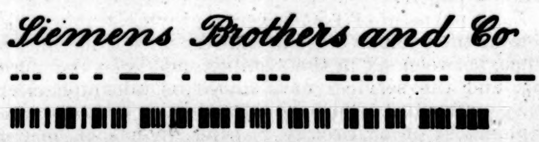

FIG. 1.

Various suggestions have from time to time been made with the object of remedying this defect, but owing either to complication in the methods of transmission or of reception, none of these proposals have been adopted to any considerable extent.

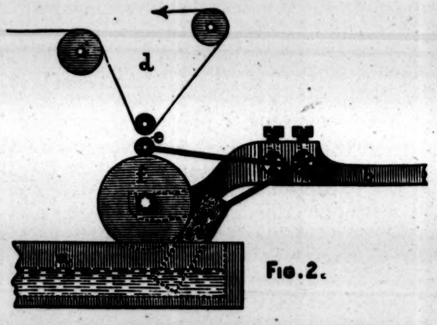

FIG. 2.

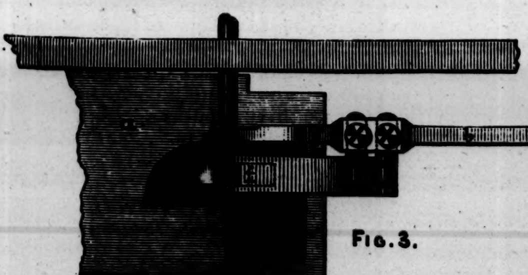

FIG. 3.

The "compact writing" has been designed to meet the demand for improvements in the old system of Morse writing. Its elementary signs consist of lines at right angles to the edge of the paper strip, and of equal width but of different length (measured in the direction in which the paper travels), a short, or thin line representing a "dot," and a longer, or thicker, line a "dash."

Fig. 1 illustrates the old and new system of writing, and shows the relative difference in space occupied by them. The length of paper used for the compact writing is about half that used for the old writing, while a more readable message is produced. The amount of paper strip to be stored away for possible future reference thus becomes considerably less—an administrative advantage not to be underrated when the present enormous increase in telegraphic communication is taken into account.

The inking arrangement by which these compact signs are produced consists, as shown in figs. 2 and 3, of a marking roller, *e*, of small diameter and of a width equal to that of the marks to be produced, mounted with its axis at right angles to the edge of the paper strip, and rotated by its frictional contact with the inking disc, *f*. This inking disc is carried on a spindle, *c*, resting in a bearing on the end of the armature lever, *b*, and is geared with the clockwork of the instrument by which it is revolved. It is of slightly greater width than the marking roller, and has a finely grooved periphery for more effectually taking up the ink. *a* is an ordinary ink trough, and *g* is a pad of felt which dips into the ink and presses against the inking disc.

The marking roller, *e*, and the inking pad, *g*, are both attached to the armature lever by flexible arms, and the amount of their pressure upon the inking disc is regulated by small set screws. *d* is the ordinary train of wheels over which the paper passes.

When the instrument is at work the end of the armature lever carrying the marking roller, inking disc and inking pad, is moved upwards by the action of the electro-magnet, the marking roller being thereby pressed against the paper, making a short or long mark, according to the duration of contact. The inking disc is rotated by the clockwork, and, being supplied with ink from the pad, carries it to the marking roller, which it, at the same time, causes to revolve. In this manner the marking roller receives a very even, though ample, supply of ink, and a freshly inked surface is constantly presented to the paper, by which means, combined with the very small diameter of the roller, short, sharp and distinct marks are produced.

Experience has, it is said, shown that any disinclination that may be felt by telegraph operators to change the method of writing the Morse code is soon removed by the conviction that the new system offers considerable advantages to themselves, and that no difficulty whatever is experienced by the change from the old system to the new. A further reference to this apparatus may be seen in our leaderette pages.

NEWSPAPERS AND PRIVATE TELEGRAPH WIRES.

IF it be true on the one hand that telegraphy has powerfully operated in the development of the newspaper press in recent years, it is equally the fact on the other hand that the newspapers have enlarged the scope of telegraphic work to an extent which it could not otherwise have attained. Indeed, at the present moment it may be said that while the press could not continue in its existing essential form without the aid of the telegraphic facilities it now enjoys throughout the universe, so the telegraphic systems could not be carried on if press work ceased and it had to depend solely upon the private messages of the public. What may be said of the whole world in this respect may be applied in the same way to this country by itself, and with all the more force because whatever may have happened elsewhere in later times, this mutual development of press and telegraphs received its first impulse in England. Even thus limited the subject is one capable of and deserving lengthy treatment; but we propose only to consider one branch of the question. London journals are, of course, largely supplied with home news by the general public telegraph wires; and provincial papers are fed in the same way with both London and country intelligence. Where this takes place the messages are transmitted in the same way as private telegrams, except that instead of the sixpence for twelve words charged to the public, messages intended for publication in newspapers are sent at a very much cheaper rate during the daytime, and at a still lower rate after six o'clock in the evening, and throughout the night. The general cessation of business involving telegraphing after six o'clock also enables the postal authorities to devote certain wires and arrange various circuits in such a way as to expedite the transmission of the enormous quantity of news entrusted to them, even on ordinary evenings, and the yet greater amount on the occasion of important political speeches in the country, or big debates in Parliament. As a sample it is worth mentioning that on April 8th, 1886, when Mr. Gladstone introduced his famous Home Rule Bill one million and fifty thousand words were wired to the country from the General Post Office alone. This represents about five hundred columns of the *Times*. On two other occasions in the same Session nearly a million words were transmitted from the central station; and this, it must be remembered, was apart from and in addition to all the miscellaneous matter sent from and to London, and throughout the rest of the kingdom.

These examples by themselves illustrate effectually the inter-dependence of newspapers and telegraphs; but our immediate interest lies not with the general service, but with the private special wires hired from the Post Office by the leading provincial journals. The growth of the provincial press is one of the most extraordinary events of the last half century. London being the heart of the United Kingdom it is natural that it should have always had a solid proportion of the whole of the papers published. Thus fifty years ago there were issued in the metropolis 85 newspapers, as against 237 in the English provinces and 136 in Scotland and Ireland. At the present time London produces (approximately) 460, while the English provincial papers number 1,240, and the Irish and Scotch 300. The proportion remains practically the same, but the important point of difference is that whereas a large number of the metropolitan journals now are class or trade weekly organs, by far the greater number of the country papers are, whether daily or weekly, strictly general newspapers. The growth of the provincial daily press has greatly surpassed that in London, and in these days many country journals exercise an amount of interest not alone in their own districts, but in the capital and throughout the land, second only to that of the most powerful metropolitan papers. At the same time their news supply, both home and foreign, is for all practical purposes quite on a level with the London service, such difference as there may be in favour of the latter being only in quantity—not in quality. For this the special wire system is largely entitled to credit.

Up to about 25 years ago the country papers were entirely dependent for telegraphed news upon the ordinary general wires, and these were very limited in number and in area. The effect was to restrict them in the main to local information, or such news as could be conveyed by train, for while the facilities of telegraphing were much smaller than they are now, the cost was considerably greater. But when the Government acquired the various private companies' telegraphs, and a new and uniform system was introduced, a bold new departure was entered upon by a Scotch newspaper, which laid the foundations of what is now an important department of the Post Office organisation. In the old times both Scotch and Irish, and also the more distant English towns had to wait virtually, or actually, a whole day for any intelligence which appeared only in London—that is to say, until the London papers reached them by railway. Few people were likely to have the leisure or the inclination to read news a day late, and the consequence was that provincial readers were anything but well informed on Imperial matters or on foreign affairs. But a revolution in this state of affairs was brought about. An Edinburgh daily hired a special wire from the Post Office direct from the head office in the Scotch capital to a London office established for the purpose, with a special London staff. The venture produced a great and rapid effect. By means of this private wire the best information published in the London papers could be at once sent through to the Edinburgh office in time for publication in Scotland; news which otherwise would only have reached the London papers, was received simultaneously in the special wire office, and in these and in many other matters this Scotch journal, at least 400 miles away, was placed on a level with its Metropolitan contemporaries. The example was soon followed first by Scotch rivals, then by Irish papers, and afterwards by English provincial offices. At the present time at least 20 of the leading papers at a distance from London have private wires, most of them only one each, but several of them two, the wires numbering altogether about 30; their own special offices and journalistic staffs, in Fleet Street, as a rule; their own reporters in Parliament, and organisations as complete for all purposes as those of the most perfect London papers.

For a payment of £500 a year a provincial newspaper obtains the exclusive use of a direct wire from office to office, between six in the evening and six in the morning, and the services of a first-class telegraph clerk. Only matter intended for publication, or brief messages explanatory of or directly bearing upon such matter, are allowed to be transmitted over this wire. No communication of a personal character such as would naturally go over the public wires, must be forwarded, and if one should be sent, the office is charged for it at the public rate. Subject to this restriction, and to the condition that in emergency, such as the disarrangement of the telegraphs by storm or other cause, the Post Office may disconnect the newspaper office at either end and summon the clerk to the central station to work from there as may be practicable, the newspaper can send any quantity of news, and as it pleases, over the wire during 12 hours. Scotch and Irish papers having followed suit, the *Manchester Guardian* led the way in England, by engaging a private wire in 1870, almost simultaneously with the outbreak of the Franco-Prussian war, and a second one within about 12 months. Under the exceptionally stirring circumstances of that period this enterprise gave the *Guardian* an immense advantage over all its direct and indirect rivals in the North of England. Other Manchester papers were compelled to adopt the same plan, the *Guardian* having, however, gained a long start and great prestige. Liverpool, Leeds, and Newcastle gradually embarked upon the like undertaking; the necessity of special wires was recognised and accepted yet further north, in Scotland and in Ireland, and also, though quite recently, in the West of England. The result is shown by the following particulars as to this system as now existing:—

Manchester Guardian, 2 wires; *Manchester Courier*, 2; *Manchester Examiner*, 1; *Liverpool Courier*, 2; *Leeds Mercury*, 1; *Yorkshire Post* (Leeds), 2; *Newcastle Chronicle*, 1; *Newcastle Journal*, 1; *Newcastle Leader*, 1; *Scotsman* (Edinburgh), 2; *Scottish Leader*, 1; *Glasgow Herald*, 2; *Glasgow Daily Mail*, 2; *Aberdeen Free Press*, 1; *Dundee Advertiser*, 1; *Belfast News Letter*, 1; *Freeman's Journal*, 1; *Irish Times*, 1; *Western Morning News* (Plymouth), 1; *Manchester Evening News*, 1. The *Liverpool Daily Post* had its own wire at one time, but it relinquished it a few years ago. The *Scottish News* had two wires, but the paper is dead; and a short-lived Southport paper also had two wires at its command, but they could not avert its early decease. Assuming that the Post Office has sufficient wires at its disposal from six to six, the only restriction is that the paper requiring a special wire shall be more than 200 miles away from London. This being the case, it is strange that neither of the old-established dailies in

Birmingham should have adopted this system, and that the Sheffield papers are in the same position; but £500 a year for one wire is a good round sum to sink, especially as the possession of the wire involves rent, salaries, and other charges attached to a London office, and almost inevitably leads the paper on to more and more expense for special arrangements by which the wire enables the paper to shine in its area of circulation. Two elaborate news agencies supply country papers with excellent services of intelligence, but a private wire is becoming a greater necessity to a provincial paper day by day. The wire last mentioned in our list is the beginning of a new development of this system. All the other papers named are morning publications, but the *News* is an evening paper. It was one of the very earliest of the evening newspapers; it was, and probably still is, the most prosperous; and this, its latest enterprise, points to a not far distant period when the provincial half-penny evening editions, which are rapidly becoming a most important institution, will equal their morning competitors even in the matter of private wires from London.

The value of this branch of English journalism to proprietors, to editors, and to readers, is far greater than can be readily described. The Post Office, with its ever increasing organisation, could of course undertake the work for each customer, but in that case the papers would have to take their chance, or their turn; one paper gaining priority might block the line with second-rate matter, while another, having urgent and important news to communicate would be kept waiting till its value was almost destroyed; they would have no control whatever over the transmission, and they would lose all the great advantage of having instantaneous communication with the chief office and London, which enables each to adapt itself to the other, and so to save precious time and trouble. Having its own wire entirely in its own hands, a paper can receive direct, immediately and up to the last minute, its commercial intelligence, its Parliamentary, law and general reports; the latest political and other news in London, and a thousand and one other matters which would never reach it in time for the next morning's issue, if it had to travel over the general wires. Last, and the reverse of least, such a paper is able, by getting the earliest possible copy of the London papers, to telegraph from Fleet Street, or wherever the London office may be, the most valuable items of information contained in those papers, in time for a second edition published at about six o'clock. Thus, while the *Times* or the *Standard* is travelling down by the five o'clock newspaper train, readers hundreds of miles away have absorbed with their breakfasts the cream of the London papers, as well as their own local journals, and are primed for the day's work with all the intelligence, home or foreign, it is necessary they should have. And by mid-day this is supplemented by evening editions, and only the least occupied, or the most devoted of subscribers will trouble the *Times* or the *Standard* when it does arrive. The rapid growth of the special wire service has naturally imposed a good deal of work, outlay and anxiety upon the Post Office authorities; but it is well worth while. With 30 wires they are sure of a fixed revenue of £15,000 a year, and this is almost daily increased by the transmission, which is separately charged for at the rate of one shilling per 100 words, of considerable quantities of matter which must be sent, but which the special wires cannot get through in time for publication. The instrument employed on these wires is, as a rule, the Morse, and some of the operators transmit "copy" with marvellous celerity, often for many hours at a stretch. Although it is not strictly within the purview of this sketch, it may be mentioned that the *Times* and *Daily Telegraph* have in a similar way (but at a much higher cost) the use of a special wire each from Paris during the night; *Galignani's Messenger* has the same facility between Paris and its Strand office; and the *Daily News* has the use of a wire from the French capital for a few hours each evening.

ON THE DESIGNING OF CONTINUOUS CURRENT DYNAMO MACHINES.

By Prof. JAMIESON, M.Inst.C.E., F.R.S.E.

NO machine has received such constant and unremitting attention of late as the dynamo, both from men of science and from practical engineers. From being a comparatively badly designed machine, giving but 50 to 60 per cent. commercial efficiency in 1880, it now reproduces quite 70 per cent. of the dynamic power applied to it in the form of useful electrical power, and the electrical efficiency often exceeds 90 per cent. Until within a very few years ago, dynamos were designed and proportioned by a rule of thumb system, or trial and failure until moderate success was attained. If a maker had luckily hit upon successful results from one machine he copied by proportion the dimensions and materials arrived at for his other larger or smaller machines, without exactly knowing the precise causes which gave success in the one case, or failure in the other. Now all that is changed, thanks to the mathematical and experimental investigations of Dr. John Hopkinson, Prof. S. P. Thompson, Mr. Gisbert Kapp, and many of the more eminent makers of dynamos, as well as to the very exact experiments by Prof. Ewing on the magnetic permeabilities of different classes of iron.

If a dynamo is now required to give any desired power, the whole of its proportions and sizes can be calculated and drawn down with such accuracy that, when constructed, it will fulfil the stipulated conditions to within 2 or 3 per cent., with a minimum of experiment and alteration in the workshop.

Let me here add, the power is not measured by any system of "nominal power," but by actual, useful output. Engineers have of late been discussing in this Institution whether or not they should adopt one or other of the various rules for estimating the "nominal horse-power" of steam engines. Nothing gives greater annoyance to an electrical engineer than having to reply to the question, "What is the nominal horse-power required to drive such and such a dynamo?" He at once discards this term, and deals directly with the brake, or indirectly with the indicated horse-power of the engine.

In the short time at the disposal of the author, he proposes to confine his remarks and calculations to "Continuous current constant pressure compound dynamos," as now used for supplying current to ordinary incandescent lamps arranged upon the parallel system, or those dynamos which work in accordance with the methods illustrated by figs. 1 and 2.

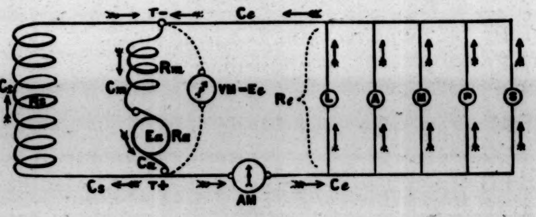

FIG. 1.

THEORETICAL DIAGRAM OF FARADAY DYNAMO CONNECTIONS.

C_a, C_m, C_s, C_e, represent the currents in the armature main magnet coils, shunt coils, and external circuits respectively, the direction of these currents being indicated by arrows.

R_a, R_m, R_s, R_e, represent the resistances of these same parts.

E_a and E_e represent the electromotive force or pressure generated in the armature, and the external E.M.F., or difference of pressure between the positive and negative terminals (T + and T −) respectively.

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* Received and held as read before the Institution of Engineers and Shipbuilders in Scotland, January 22nd, 1889, and discussed February 26th.

A M and V M represent current and pressure meters, or ampère and volt meters.

It is not our intention to enter here into the many mechanical and electrical arrangements of dynamos, or to trace the manner in which dynamos have been gradually simplified and cheapened. Yet as many of the members of this Institution are not familiar with the internal construction of such machines, we think that the simple illustrations may assist them, and lead them to take a greater interest in the principles and formulæ which follow.

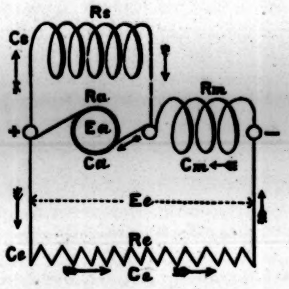

FIG. 2.—THEORETICAL DIAGRAM OF RANKIN KENNEDY DYNAMO CONNECTIONS.

The first skeleton figure gives an idea of the general arrangement of the series Gramme dynamo,* one of the few, and certainly the best machine in the market in 1880.

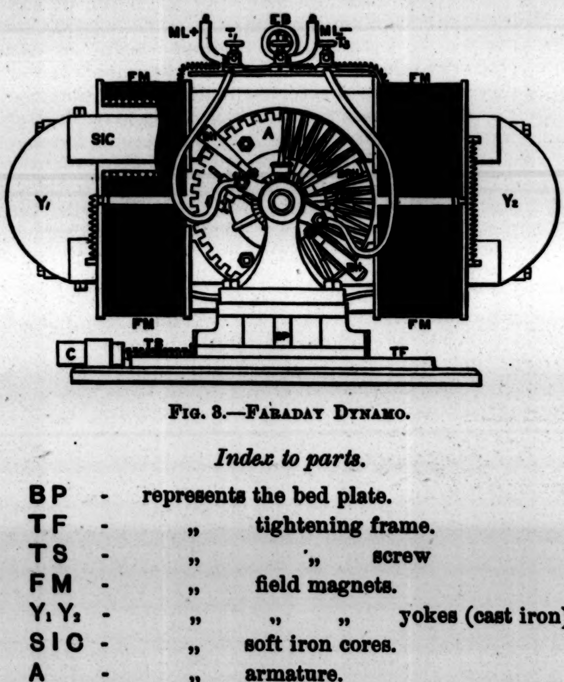

FIG. 3.—FARADAY DYNAMO.

Index to parts.

BP - represents the bed plate.
TF - „ tightening frame.
TS - „ „ screw
FM - „ field magnets.
Y_1 Y_2 - „ „ „ yokes (cast iron).
SIC - „ soft iron cores.
A - „ armature.
BH_1 BH_2 „ brush handles.
ML + ML − „ main leads (positive and negative).
T_1 T_2 T_3 „ terminals.

Fig. 3 illustrates the Faraday dynamo, as made in 1887-88. This form of dynamo gives excellent results, but the makers, finding that it is more expensive to construct than the Kennedy dynamo shown by fig. 4, they are now getting out a set of patterns to meet the present popular craving for cheap machines, with cast iron core and pole pieces having but one joint instead of a wrought iron core and two joints.

The power given out and absorbed by dynamos is measured in watts, which is simply the product of the current in ampères, and the electrical pressure in volts. The current generated by a dynamo depends directly upon the total electrical pressure developed, and inversely upon the total resistance of the circuit (internal and external), as well as upon any back electrical pressure such as is experienced when charging accumulators or when driving motors. Neglecting this latter effect, which does not take place when merely lighting incandescent lamps,

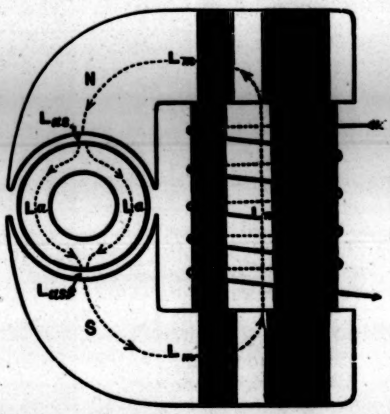

FIG. 4.—MAGNETIC CIRCUIT OF SINGLE BOBBIN HORSESHOE KENNEDY DYNAMO.

L_m represents length of field magnet circuit.
L_{as} „ length of air space circuit.
L_a „ length of armature circuit.

Let E_a represent the electrical pressure generated in the armature.
„
E_e „ external electrical pressure, or that available for useful work.
„
R_i „ internal resistance of the whole dynamo.
R_e „ external resistance of leads and lamp circuits.
C_a „ current passing through armature.
C_e „ current external, or that sent through lamp circuit.

Then, $$C_a = \frac{E_a}{R_i + R_e} = \text{total current generated.}$$

And $$C_e = \frac{E_e}{R_e} \text{ external current.}$$

$$\text{The electrical efficiency} \Big\} = \frac{C_e \times E_e}{C_a \times E_a} = \frac{\text{output in watts}}{\text{total watts generated.}}$$

Now, since C_a, E_e, and C_e depend directly upon E_a, we propose to show how this internal electrical pressure may be obtained for any dynamo of the kind under consideration.

This total or internal pressure, E_a, depends directly upon—

1. The total number of magnetic lines which flow between the field magnet poles through the armature.
2. The number of convolutions of the armature conductors which are in series at one time.
3. The speed of rotation of the armature.

The *number of revolutions* per minute is a matter that can be easily decided upon before beginning to design the dynamo. Fast speed dynamos, if well balanced, are common in land installations; slow speed ones on board ship, and where vibration and noise must be avoided.

The *number of convolutions* of the armature conductor depends upon the number of radial bars in the commutator, the diameter of the armature, and the size of wire to be used, all of which will be determined as the drawing or design proceeds in accordance with sound practice.

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* It is not necessary to illustrate this.—EDS. ELEC REV.

The *magnetic circuit* is the chief and most intricate part of the whole design which requires our attention, and we shall therefore consider it first in full detail.

I. FIELD MAGNET CIRCUIT.

The field magnet circuit should have as little magnetic resistance as possible. The magnet cores, &c., *should* therefore be made of the best soft Swedish iron, short, of large sectional area, and with no joints. Owing, however, to expense, the difficulty of winding the wire on the magnets, or the fixing of bobbins containing the wire, and the necessity of having sufficient residual magnetism with which to start the dynamo current, and to prevent fluctuations of current, the yoke (if there is one) and the pole pieces are frequently made of cast iron.

In a Kennedy dynamo, fig. 4, the mean length of the magnetic circuit is indicated by the letter L_m, and the poles are marked N and S.

II. AIR SPACES.

The air spaces should have the least possible magnetic resistance. They should, therefore, have as little depth as is consistent with preventing actual contact between the armature wires and the pole pieces, and of allowing free circulation of air, and of preventing heating of the pole pieces due to Foucault or eddy currents in the forward ends of the pole pieces.

In fig. 4 the two air spaces are marked L_{as}, L_{as}.

III. ARMATURE CORE.

The armature core should have as little magnetic resistance as possible, and be as free as possible from inducing Foucault currents. It should, therefore, be built up of the softest thin Swedish iron plates, well insulated from each other, and laminated or placed in a direction parallel to the direction of the magnetic lines passing between the poles of the field magnet. Some makers prefer to build up their armature cores of soft iron wire insulated by the natural thin coating of oxide of iron always found on such wire.

In fig. 4 the mean directions of the split magnetic circuit through the armature core are marked L_a and L_a.

IV. MAGNETIC RESISTANCE OF FIELD MAGNET CIRCUIT.

The magnet circuit, L_m, has a magnetic resistance.

$$R_m = 2\,\frac{L_m}{S_m}.$$

Where—

2 = Kapp's coefficient for the initial specific magnetic resistance of soft wrought iron (the number 3 to be used if core, &c., be of cast iron).

L_m = the mean length of field magnet circuit in inches.

S_m = sectional area in square inches (at right angles to L_m) of magnet core.

V. MAGNETIC RESISTANCE OF AIR SPACES.

The air spaces circuits, L_{as}, L_{as}, have a resistance,

$$R_{as} = 1{,}440\,\frac{2\,L_{as}}{S_{as}}.$$

Where—

1,440 = Kapp's coefficient for the specific magnetic resistance of air and copper when wrought iron magnets are used (1,800 to be used with cast iron magnet cores and pole pieces, and 1,500 with wrought iron cores and cast iron poles).

L_{as} = depth of each air space in inches (and since there are two spaces, 2 L_{as} is inserted in the formula).

S_{as} = sectional area of each air space or surface area of each pole piece in square inches.

VI. MAGNETIC RESISTANCE OF ARMATURE CORE.

The armature core circuits, L_a, L_a, have a magnetic resistance.

$$R_a = \frac{L_a}{S_a}.$$

Where—

L_a = mean average length of armature core magnetic circuit in inches (if there was only but one path instead of two we should have to multiply by the coefficient 2, as in equation (IV.), but $2\,\frac{L_a}{2} = L_a$).

S_a = cross sectional area of armature core in square inches
= twice radial depth × length of armature core.

VII. TOTAL MAGNETIC RESISTANCE.

The total magnetic resistance of the complete magnetic circuit is therefore—

$$R_m + R_{as} + R_a = 2\,\frac{L_m}{S_m} + 1{,}440\,\frac{2\,L_{as}}{S_{as}} + \frac{L_a}{S_a}.$$

VIII. KAPP LINES.*

The total number of Kapp lines, K_L, of magnetic force which pass through the magnet and air space, can therefore be calculated by *dividing* the ampère-turns ($A \times T_{mw}$) on the magnet windings by the total magnetic resistance in the magnetic circuit.

Or

$$K_L = \frac{A \times T_{mw}}{R_m + R_{as} + R_a}$$

i.e.,

$$K_L = \frac{A \times T_{mw}}{2\,\frac{L_m}{S_m} + 1440\,\frac{2\,L_{as}}{S_{as}} \times \frac{L_a}{S_a}}.$$

IX. E.M.F. IN ARMATURE.

The E.M.F. developed internally in the armature winding is :—

$$E_a = K_{La} \times T_{aw} \times N_{ar} \times 10^{-6}.$$

Where—

E_a = E.M.F. developed in armature in volts.

K_{La} = Kapp lines which only pass through armature or the useful field.

T_{aw} = turns of armature wires in series (counted all round core).

N_{ar} = number of armature revolutions *per minute.*

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[*] A Kapp line is simply = 6,000 C.G.S. magnetic lines. Kapp proposed this unit (see *Journal Society Telegraph-Engineers and Electricians,* Vol. XV., p. 518, 1886) as a suitable factory unit for dynamo use, on account of the C.G.S. unit being so small; also from the fact that the revolutions of dynamo armatures are usually reckoned per minute instead of per second, and that British workmen still measure sectional areas in square inches instead of square centimetres as in the C.G.S. system.

The number 6,000 is made up of two terms, viz., 60, which enables revolutions to be counted per minute instead of per second; and 100, to bring down the measurement of the magnetic lines to reasonable numbers; or $\frac{\text{C.G.S. lines}}{60 \times 100} = \frac{\text{C.G.S lines}}{6{,}000}$. Then, 1 Kapp line = 6,000 C.G.S. lines.

Since there are 6·4514 square centimetres in a square inch,

One Kapp line per square inch = $\frac{6{,}000}{6{\cdot}4514}$ = 930 C.G.S. lines per square centimetre. Consequently, instead of saying 18,600 C.G.S. lines, we simply say 20 Kapp lines, or $\left(\frac{18{,}600}{930}\right)$, which gives small numbers more easily expressed and understood by those engaged in dynamo construction; in the same way that for long distances we prefer to measure lengths in miles instead of in yards or in inches. I have not explained how Mr. Kapp arrived at the above constants, or how they agree (for all practical purposes) with Hopkinson's formulæ, viz., that the magnetic resistance of each part of the circuit is proportional to its length, and inversely proportional to the product of its sectional area and magnetic permeability (as found by experiment at a particular magnetic density).[*]

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[*] These points were fully explained on the evening of the discussion, and will be found in the Journal of the Institution of Engineers and Shipbuilders, of Scotland, for 1888—1889.—EDS. ELEC. REV.

EXAMPLE I.*—Let us now apply the foregoing formulæ to the design of a single field compound dynamo of similar form to that shown in fig. 2.

Let the dynamo be furnished with a long shunt, and be of 6,400 watts (external power, P_w), when driven at 1,000 revolutions per minute.

First, let us determine the resistance, current, fall of potential, in armature and magnets, and percentage loss of power in the armature, shunt, and main field magnet coils, using the same symbols as before.

Given $E_e = 100$ volts.

$C_e = 64$ ampères.

Resistances.—

Then $R_e = \frac{E_e}{C_e} = \frac{100\ v}{64\ a} = 1{\cdot}55$ ohms.

Suppose we agree to a loss of about 10 per cent. of the total power in the dynamo, or say—

The electrical efficiency of the dynamo = 90 per cent.

$\therefore$ 90 per cent. : 100 per cent. :: 6,400 $P_w : x$.

$\therefore$ Total power $= x = 7{,}100\ P_w$.

Let $R_a = \frac{R_e}{20} = \frac{1{\cdot}55}{20} = {\cdot}077\ \omega$.

Let $R_s = R_a \times 1{,}000 = {\cdot}077 \times 1{,}000 = 77\ \omega$.

Let $R_m =$ 75 per cent. $R_a = \frac{3}{4} \times {\cdot}077 = {\cdot}058\ \omega$.

Now, the external current = current in armature and field magnet main coils less the current in shunt.

Currents.—

Or $C_e = C_a - C_s$.

But, $C_s = \frac{E_e}{R_s} = \frac{100\ v}{77\ \omega} = 1{\cdot}3\ a$.

$\therefore 64\ a = C_a - 1{\cdot}3\ a$.

$C_a = 64 + 1{\cdot}3$.

$= 65{\cdot}3$ ampères.

Fall of potential in armature ... ... $= C_a \cdot R_a = 65{\cdot}3 \times 0{\cdot}77$.

$= 5{\cdot}02$ volts.

Fall of potential in magnet main coils ... ... $= C_m \cdot R_m = 65{\cdot}3 \times {\cdot}058$.

$= 3{\cdot}78$ volts.

Total fall of potential in armature and magnet series coils

$= C_a \text{ or } C_m\ (R_a + R_m)$.

$= 65{\cdot}3\ ({\cdot}077 + {\cdot}058) = 8{\cdot}8\ v$.

$\therefore E_a = 8{\cdot}8 + E_e = 108{\cdot}8$ volts.

Percentage losses of power.—

In armature $= C_a^2 \cdot R_a = 65{\cdot}3^2 \times {\cdot}077$.

$= 330\ P_w$.

$\therefore 7{,}100\ P_w : 330\ P_w :: 100 : x_a$.

$x_a = 4{\cdot}63$ per cent.

In shunt coils $= C_s^2 \cdot R_s = 1{\cdot}3_s^2 \times 77\ \omega$.

$= 132\ P_w$.

$\therefore 7{,}100\ P_w : 132\ P_w :: 100 : x_s$.

$x_s = 1{\cdot}86$ per cent.

In main coils $= C_m^2 \cdot R_m = 65{\cdot}3^2 \times {\cdot}058$.

$= 248\ P_w$.

$\therefore 7{,}100 : 248 :: 100 : x_m$.

$x_m = 3{\cdot}5$ per cent.

Totalling the different percentage losses we have :—

In armature ... ... $x_a = 4{\cdot}63$ per cent.
In shunt coils ... ... $x_s = 1{\cdot}86$ „
In main coils ... ... $x_m = 3{\cdot}5$ „
9·99 per cent.

or say 10 per cent.

Kapp Lines in Armature Core.—Now, before substituting the above data in Kapp's formula, we must agree upon the turns of wire in the armature, at the agreed upon 1,000 revolutions per minute. Let there be 36 commutator bars or 36 sections of wire in armature, which has been found sufficient to give a current of practically uniform E.M.F. The number of turns of wire in each section of the armature depends upon whether we use double or single winding, and upon the current and the resistance of the armature wire. As we shall see further on, from our trial drawing and calculations, we can get in 6 turns of wire to each section.

$\therefore T_{aw} = 36 \times 6 = 216$ turns of armature wire.

Let $N_{ar} = 1{,}000$ revolutions per minute.

Now $E_a = K_{La} \times T_{aw} \times N_{ar} \times 10^{-6}$.

$$\therefore K_{La} = \frac{E_a}{T_{aw} \times N_{ar} \times 10^{-6}}.$$

$$= \frac{108{\cdot}8\ v}{216 \times 1{,}000 \times 10^{-6}} = 503{\cdot}7$$

say = 500 Kapp lines in *armature core*.

In order to obtain a certain number of Kapp lines, or magnetic induction, in an armature core, it is necessary to give a greater magnetic intensity to the field magnet core or cores, owing to the unavoidable leakage of magnetic lines which do not pass through the armature core.

Dimensions of Magnet Core.—In ordinary practice it is usual to assume that only about 80 per cent. of the field magnet lines pass through the armature core.

Therefore, the Kapp lines in *Field Magnet* are,

80 per cent. : 100 per cent. :: 500 : $x = 625$.

We must now ascertain the dimensions of the field magnet core to carry these 625 Kapp lines. Suppose we consider the case of field magnets to be cast iron throughout (poles and core).

A safe working density is 9 Kapp lines per square inch.

$\therefore S_m = \frac{625}{9} = 69{\cdot}4$ square inches.

$= 9{\cdot}4$ inches diameter (if round).

In practice it is found that a dynamo magnet bobbin should be in length about $1\frac{1}{4}$ times its diameter to give the necessary space for winding or ampere turns.

$\therefore 9{\cdot}4 \times 1{\cdot}25 = 11{\cdot}75$ inches long.

Dimensions of armature core.—It has been found advisable, in designing the dimensions of the armature core of a dynamo having a field magnet of the form we are now considering, to make the diameter of its core slightly larger, and its length slightly less, than the diameter of the field magnet core.

Therefore, calling the diameter of the Gramme armature core 10 inches, its length 9 inches, and allowing a density of 20 Kapp lines per square inch of core section, since it is made of the best permeable wrought iron.

We have $\frac{500}{20} = 25$ square inches total cross section of armature,

$\therefore S_a = 25$ square inches.

Allowing 20 per cent. of total space for insulation between *laminated plates* in armature core, we have

80 per cent. : 100 per cent. :: 25 : $x = 31{\cdot}5$ sq. in.

$\therefore \frac{31{\cdot}5}{2} = 15{\cdot}75$ square inches in each half.

$\therefore \frac{15{\cdot}75}{9''} = 1{\cdot}75$ inches = radial depth of core.

Magnetic resistance of field magnet.—Now, drawing armature and field magnets to scale as per fig. 4, and allowing $2\frac{1}{2}$ inches for depth of winding on field magnet bobbin and clearance for armature, we find the mean length of field magnet core, $L_m = 44$ inches, and remembering that in a formula for the magnetic resistance of this part of the circuit we have to use a coefficient of 3 instead of 2, seeing that the core is of cast iron,

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* The calculations for Example I. were made by Boucher's calculator, and thus are therefore only approximately true.—A. J.

We have
$$R_m = 3\,\frac{L_m}{S_m}$$
$$= 3\,\frac{44}{69{\cdot}4} = 1{\cdot}9.$$

Magnetic resistance of air space.—With *two* layers of insulated conductors having a cross section (▭) of ·08 inch deep, by ·2 inch broad (including covering), we find the total depth of air space on one side between pole pieces and armature core (allowing ·14 inch mechanical clearance), equal ·3 of an inch.

Consequently, $2\,L_{as} = 2 \times {\cdot}3 = {\cdot}6$ inches.

The bore of pole pieces will be = diameter of armature core + $2\,L_{as}$

= 10 inches + ·6 inches = 10·6 in.

It is good practice to allow the corners of pole pieces to form an angle of 30° with centre of armature. The angle embraced by each pole piece will therefore be 180° − 30° = 150°, which gives us a circumferential length of, say, 14 inches for each pole. And since our armature coil is 9 inches long, and it is unusual to make the pole pieces broader than this length, we have

$S_{as} = 14$ inches × 9 inches = 126 square inches.

Hence—
$$R_{as} = 1{,}800\,\frac{2\,L_{as}}{S_{as}}$$
$$= 1{,}800\,\frac{2 \times {\cdot}3}{126} = 8{\cdot}5$$

Magnetic resistance of armature.—Referring to scale or full-size section, we find by measurement that, L_a = 15 inches. We have already determined S_a to be 25 square inches.

Consequently—
$$R_a = \frac{L_a}{S_a},$$
$$= \frac{15}{25} = {\cdot}6.$$
$$\therefore R_m + R_{as} + R_a = 1{\cdot}9 + 8{\cdot}5 + {\cdot}6$$

= 11 Kapp units of magnetic resistance.

Ampère Turns.—From formula for *cast* iron, under heading VIII.

$$K_L = \frac{A \times T_{mw}}{R_m + R_{as} + R_a} = 625 \text{ (Kapp lines)}$$
$$\therefore A \times T_{mw} = K_L\,(R_m + R_{as} + R_a),$$
$$= 625 \times 11,$$

= 6,875 total ampère turns in shunt and main field magnet coils.

Proportioning of Ampère Turns between Shunt and Main Coils.—The total ampère turns have now to be divided in proper proportion between the series coils and the shunt coils of the field magnet windings.

In order to do this, so as to give the desired form of characteristic curve, we must have recourse to actual experiment. The following method is carried out by Messrs. M'Whirter, Ferguson & Co., Faraday Works, Govan.

1. A workshop bobbin or experimental coil, with a known number of turns of wire, is kept for every size of dynamo machine made. This bobbin is put on to the magnet core in circuit with an ampèremeter and is separately excited by another dynamo or storage cells. The dynamo to be wound is run at the normal speed with the external circuit, R_s, equal to that of shunt, viz., 77 ω, and with the voltmeter placed between the terminals. The exciting current through the experimental bobbin is now gradually increased until the required number of volts is observed on the voltmeter. *E.g.*, suppose the experimental bobbin to have 500 turns, and the ampèremeter reads 8·25 ampères, when the normal voltage of 100 volts is reached, then the ampère turns of shunt wire

$$A \times T_{sw} = 500 \times 8{\cdot}25 = 4{,}125 \text{ ampère turns.}$$

2. Connect up the armature of the dynamo being constructed to a resistance equal to the joint resistance of the shunt and the normal lamp circuit through an ampèremeter, and run the dynamo at the normal speed. Now increase the exciting current in the experimental bobbin until the normal voltage of 100 volts and normal armature current of 65·3 ampères are both obtained. At the same time observe the exciting current.

But the total required ampère turns = 6,875, and from experiment (1) we found that 4,125 ampère turns produced the requisite E.M.F.

∴ 6,875 − 4,125 = 2,750 amp. turns left for series coils.

3. The normal current at full load required to pass through the series coil was found to be 65·3 amperes.

Consequently the number of turns required in the series coils

$$= \frac{2{,}750}{65{\cdot}3} = 42 \text{ (about).}$$

4. From experiment (1), we found that 4,125 ampère turns gave us the required excitation to produce the normal E.M.F., and from our former calculation, we found that the current in shunt,

$$C_s = 1{\cdot}3 \text{ ampères.}$$
$$\therefore \frac{4{,}125}{1{\cdot}3} = 3{,}173 \text{ turns.}$$

But the series coils are also carrying the 1·3 ampères required for the shunt when dynamo free.

∴ 3,173 − (42 turns × 1·3 *a*) = 3,173 − 54 = 3,119 turns on shunt coils.

5. All we now have to do is to so proportion the size of our series and shunt coil conductors that they shall carry the necessary currents required in each case at the rate of not exceeding 1,000 ampères per square inch. For armatures this may be and is in practice increased to even 3,000 ampères per square inch without undue overheating, owing to the cooling effect of the air carrying off the heat generated in the revolving armature. Mere radiation only acts on the field magnet coils; therefore, the sectional area is of necessity much greater.

EXAMPLE II.—Now take the case of a Rankin Kennedy short shunt compound dynamo of the form shown by fig. 1. The particular dynamo in question was tested by the writer after completion with the following results :—

Resistance of armature, warm,	R_a =	·04 ohm.
Resistance of magnet shunt, warm,	R_s =	20 ohms.
Resistance of magnet main coil, warm,	R_m =	·03 ohm.
Current in working circuit,	C_e =	108·5 amps.
Current in shunt magnet coils,	C_s =	5 amps.
Diff. of potential at dynamo terminals,	E_e =	100 volts.
Difference of potential at brushes,	E_b =	103 volts.
E.M.F. generated in armature,	E_a =	108 volts.
Turns of armature wire,	T_{aw} =	180.
No. of armature revolutions per min.	N_{ar} =	620.

ELECTRICAL EFFICIENCES.

External electrical power, or "output," available for electric lighting, &c.,

$= C_e \times E_e = 108{\cdot}5_a \times 100v = 10{,}850$ watts $= 88{\cdot}7$ per cent.

Power absorbed by armature,

$= C_a^2 \times R_a = (113{\cdot}5)_a^2 \times {\cdot}04\,\omega =$ 515 watts = 4·2 per cent.

Power absorbed by shunt magnet coils,

$= C_s \times E_s = 5_a \times 103v =$ 515 watts = 4·2 per cent.

Power absorbed by main magnet coils,

$= C_m^2 \times R_m = (108{\cdot}5)_a^2 \times {\cdot}03\,\omega =$ 353 watts = 2·9 per cent.

Total electrical power,

$$\left.\begin{array}{l}(C_e \times E_e) + (C_a^2 \times R_a) \\ + (C_s \times E_s) + C_m^2 \times R_m)\end{array}\right\} = 12{,}233 \text{ watts.}$$

The only difference between this dynamo and our last example being that the magnet core was made of the best hammered scrap iron instead of cast iron, and consequently the permeability is greater. The constants to be used in the formula are therefore less, and we have to substitute 2 for 3, and 1,500 for 1,800 as found by experiment.

From the measured dimensions of the dynamo we found :—

$L_m = 38$ inches. $S_m = 98$ square inches.
$L_{as} = 0{\cdot}45$ " $S_{as} = 195$ " "
$L_a = 15$ " $S_a = 46$ " "

$$\therefore R_m = 2\frac{L_m}{S_m} = 2\frac{38}{98} = {\cdot}76.$$

$$R_{as} = 1{,}500\frac{2\,L_{as}}{S_{as}} = 1{,}500\frac{2 \times {\cdot}45}{195} = 6{\cdot}9.$$

$$R_a = \frac{L_a}{S_a} = \frac{15}{46} = {\cdot}33.$$

$$\text{Total magnetic resistance} = 7{\cdot}99.$$

Now, by substituting in our former formula the actual values obtained for the E.M.F. in the armature, turns of armature wire, and revolutions per minute, we get the magnetic flux in Kapp lines flowing through the armature. Or,

$$K_{La} = \frac{E_a}{T_{aw} \times N_{ar} \times 10^{-6}}$$

$$= \frac{108}{180 \times 620 \times 10^{-6}}$$

= 968 *lines of magnetisation through armature, or at the rate of* 21 *Kapp lines per square inch.*

But in dynamos of this class it has been found that the number of magnetic lines passing through the armature are only 80 per cent. of the total magnetisation in the field magnets. Consequently,

80 per cent. : 100 per cent. :: 968 : x

$\therefore x = 1{,}210$ *Kapp lines through the magnet cores, or at the rate of* 12·3 *Kapp lines per square inch.*

From our former formula,

$$K_L = \frac{A \times T_{mw}}{R_m + R_{as} + R_a}$$

$$1{,}210 = \frac{A \times T_{mw}}{7{\cdot}99}$$

= 9,668 ampère-turns on the field magnets.

The actual ampère-turns were 9,800, or the calculation is only about 1 per cent. less than the *actual* amount required to satisfy the requirements of the installation.

EXAMPLE III.—Take the case of a Faraday compound dynamo, also tested by the writer, supplied by Messrs. M'Whirter, Ferguson & Co., Govan, to the Blair Lodge School. Where (see fig. 3)

$R_a = {\cdot}0315\,\omega$ $E_e = 100$ v
$R_s = 31{\cdot}0\,\omega$ $E_a = 107{\cdot}6$ v
$R_m = 0{\cdot}012\,\omega$ $E_b = 102$ v
$C_e = 130{\cdot}0\,a$ $T_{aw} = 240$ (48 commutator bars)
$C_s = 3{\cdot}55\,a$ $N_{ar} = 800$

This dynamo being of the double horseshoe magnet type, and the cores being of the best Swedish iron, with large cast iron yokes we use a constant 2 for wrought iron cores, and 1,440 for specific resistance of copper and air space due to wrought cores and pole pieces.

From the actual dimensions of the dynamo we found :—

$L_m = 32{\cdot}0$ in. $S_m = 33$ sq. in. (only 1 magnet core).
$L_{as} = 0{\cdot}5$ " $S_{as} = 54$ " ($\frac{1}{2}$ air space surface).
$L_a = 12{\cdot}0$ " $S_a = 15{\cdot}6$ " ($\frac{1}{2}$ section of armature).

$$\therefore R_m = 2\frac{L_m}{S_m} = 2\frac{32}{33} = 1{\cdot}94$$

$$R_{as} = 1{,}440\frac{2\,L_{as}}{S_{as}} = 1{,}440\frac{2 \times {\cdot}5}{54} = 26{\cdot}6$$

$$R_a = {}^*2\frac{L_a}{S_a} = 2\frac{12}{15{\cdot}6} = 1{\cdot}54$$

Magnetic resistance of half dynamo field = 30·08

Now, $$K_{La} = \frac{E_a}{T_{aw} \times N_{ar} \times 10^{-6}}$$

$$= \frac{107{\cdot}6}{240 \times 800 \times 10^{-6}}$$

= 530 *lines of magnetisation through armature, or at the rate of* $\frac{530}{15{\cdot}6 \times 2}$ = 17 *Kapp lines per square inch of armature section.*

Allowing, as before, that only 80 per cent. of the total magnetisation passes through the armature, we have

80 per cent. : 100 per cent. :: 530 : x.

$x = 662$ Kapp lines through both the magnet cores, or 331 lines through each half, which is at the rate of 10 Kapp lines per square inch of magnet core section.

$$\therefore K_L = \frac{A \times T_{mw}}{R_m + R_{as} + R_a}$$

$$\text{Or } A \times T_{mw} = K_L\,(R_m + R_{as} + R_a)$$

$$\therefore A \times T_{mw} = 331 \times 2 \times 30{\cdot}08 = 19{,}913$$

The actual ampère turns were 20,850, and the dynamo having a rising characteristic of 3 per cent., the calculation is only about 1·7 per cent. less than actually found by experiment.

The discussion which took place on Prof. Jamieson's paper at the very full meeting on Tuesday, February 26th, of the Institution of Engineers and Shipbuilders in Scotland, was taken part in by Sir William Thomson, Mr. McWhirter, Mr. Andrews, Mr. Smillie, of Messrs. Denny's works, Dumbarton, a Japanese professor, &c., and the chairman, Mr. Henry Dyer, who said that they should have an electrical evening at least once every session, as there was no doubt that electrical engineering was fast becoming a branch of mechanical engineering.

Stockport and the Electric Light.—Efforts are being made to inaugurate a scheme for lighting a number of shops in Stockport by electricity. Mr. George Durham recently attended a meeting of tradesmen held for the purpose of considering the feasibility of adopting the scheme and explained the proposals which he had made.

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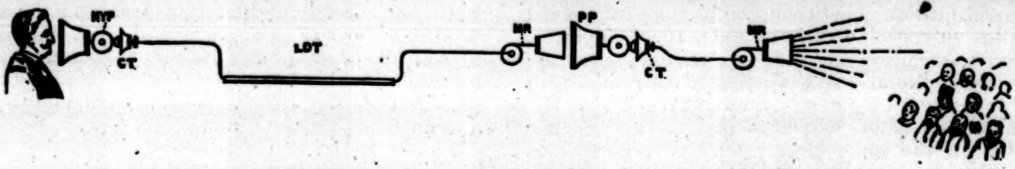
* 2 here is on account of the double field, or the magnetic lines or circuit entering from each side.

PHONOGRAPH AND TELEPHONE.

On the evening of February 4th, Mr. William J. Hammer delivered a lecture on "Edison and His Inventions" before the Franklin Institute, Philadelphia. This remarkably able lecture was replete with interest, and described in sequence all of Mr. Edison's inventions in the field of telegraphy, telephony, phonography, electric lighting, &c., all of which were made clear by a wealth of illustrations and experiments.

Perhaps the most striking experiments shown were those in connection with the telephone and phonograph, and consisting in the recording and transmitting of telephone conversation, music, &c. The first experiment undertaken was the recording on a phonograph in Philadelphia of music and talking transmitted over the long distance telephone line from New York, and reproducing the same to the audience.

Another experiment consisted in recording music and talking upon the Philadelphia phonograph which had been talked into the long distance telephone by a phonograph in New York.



PHONOGRAPHIC AND TELEPHONIC TRANSMISSION BETWEEN NEW YORK AND PHILADELPHIA.

N.Y P. New York Phonograph. C.T. Carbon Transmitters. LD.T. Long-distance telephone line, 103 miles, 6 miles underground. M.R. Motograph Receivers. P.P. Philadelphia Phonograph.

The most important test was that which is illustrated diagramatically in the accompanying sketch. This consisted in reproducing to the audience, by means of the Edison motograph receiver or loud speaking telephone, and the Edison carbon transmitter, the music and talking registered on the Philadelphia phonograph, and which had been sent over the long distance telephone line from New York (a distance of 103 miles) by the New York phonograph talking into a carbon transmitter. This wonderful experiment, as will be seen, employed two phonographs, two carbon transmitters and two motograph receivers acting in juxtaposition with 103 miles of telephone wire, six miles of which was underground. We are indebted to Mr. Hammer for a copy of the above diagram.

AN ELECTRIC MOTOR IN COMPETITION WITH STEAM.

Since January 28th last, with the exception of two days, says the *Electrical World* of February 16th, when the multiplication of elevated trains caused by the strike on the street railways interfered, the Daft electric locomotor "Franklin" has been running with the steam locomotives, and same number of cars, from 11 a.m. to 2 p.m., between the Fourteenth and Fiftieth Street stations of the Ninth Avenue Elevated Railway.

The restriction to these hours has been solely due to the necessity of switching the locomotor to the front of the train at both termini, and this operation, while readily accomplished in three minutes, would, in "commission hours," when the headway of the steam trains is nominally three minutes, and frequently less, delay the schedule service which it is the boast of the "Franklin" never to have interfered with in the many hundred miles it has run on the Ninth Avenue lines.

The tests for tractive capacity and speed, which had been varied and many from the latter part of last November up to the beginning of the present schedule service, were eminently satisfactory in all respects and unattended by the slightest mishap, delay, or disappointment. They were an unbroken success from beginning to end, and though noticed before in these columns, it is not out of place to refer to the more salient instances among them.

With eight empty cars in train, making a load of 122 tons, a speed of 7½ miles an hour was obtained up a gradient of nearly 2 per cent. without the slightest noticeable strain upon the locomotor, although the development of horse-power exceeded 120. With a four-car train, the standard for the Ninth Avenue line, carrying an average load of passengers, 15½ miles an hour were easily made up the same gradient, an excess of 2½ miles over the running time of the steam trains between stations.

The "Franklin" has on several occasions attained a speed of 30 miles per hour, and it is a thoroughly safe statement to make that in its present stage 35 miles per hour may be considered the ultimate.

While these special tests indubitably established all—and more—than was looked for, there yet remained a quality that only regular and continuous service for some length of time would fully demonstrate, and which may, for want of a recognised term, be styled reliability, a word essentially American, and rather sniffed at by lexicographers, but one for which there is no complete synonym in the language. To be "on deck" in the thousand and one unforeseen and unforeseeable emergencies that occur in the practical use of machinery of any kind; to show a minimum liability to accident or derangement; a not unreasonable wear and tear and a permanency of adjustment are qualities before which abstract economy must often give way. It is needless to say that the "Franklin" ranks high on all these counts.

There has been no noticeable sparking or flashing at the brushes, either of conductor or commutator, which have for themselves shown a surprising and unexpected uniformity of contact and endurance. Under the heaviest work it has been subjected to, *no* journal has ever heated, neither field nor armature has been perceptibly warmer, and everything unmistakably indicates that in all respects the "Frankin" possesses a large factor of safety, and so far has not approached in any direction the limit of its powers.

It may be noticed that, in the present schedule work, the electric train does not stop at stations to pick up and drop passengers, and the omission, not unnaturally, may excite some curiosity. The primary reason is that the locomotor, at present, is not supplied with means of utilising the air brakes. Though the designs are completed and will soon be carried out, the necessary reduction of speed in approaching stations with limited brake power would so increase the duration of the trip as to dangerously encroach upon the interval available for switching. Even now the occasional inevitable irregularity of the steam trains so trenches upon the time needed for this operation as to now and then interrupt the succession of the "Franklin's" trips, and the essential uniformity demanded by the experiment would be impossible, except at the risk of further impeding the delayed steam train, which it is particularly desired to avoid. Direct trips give the electric train ample time for switching without getting in the way of anything.

The economy in the application of power is peculiarly marked in this regular running. Indicator diagrams of the driving steam engine are taken with the train in motion by a mechanical expert, and the weight of the train being known, and its speed carefully noted between stations, as well as the instant of passing them, a very close comparison of the power developed by the steam engine and that utilised on the track becomes possible. The results are not yet ready for publication, but will be shortly made known in full detail. The economical principles on which electric propulsion bases its claim to recognition can hardly be as yet a generally familiar one, and a brief outline of it is not out of place. It lies in the fact of the unavoidable wastefulness of small—especially locomotive—steam engines, and the remarkable economy of large stationary compound condensing engines of modern type. The latter will readily give a H.P. hour for two pounds of coal, while the best trustworthy quoted results of passenger steam locomotives is not less than nine pounds of coal per H.P. hour. Now, while one-third of the original power, in a circuit of ordinary length, may be lost in its conversion into current by the dynamo generator and reconversion to power by the electric motor, and in overcoming the resistance of conductor and electromotive mechanism, it still is true that in the case of electrical transmission a horse-power on the track costs but three pounds of coal as opposed to nine of the steam locomotive. There are also other reasons hinging upon the interaction of currents on a circuit including several motors which tend distinctly to economy of operation.

The theory of compensation between electric locomotors working upon the same circuit was advanced several years ago by Werner Siemens, who declared, without qualification, that two electro-motors, influenced by the same current and running upon the same track, one upon an ascending and the other upon a descending gradient, are as literally and practically connected with each other as if tied together by an actual rope.

The consequence of which is that all the electric locomotors on the same circuit may be regarded as running upon a level track. The armature of the descending motor, revolving under the influence of gravity, changes its function to that of dynamo generator and restores current to the line which is available for the motor on the ascending gradients. A most interesting illustration of this theory has lately appeared in prolonged and elaborate investigations of the distribution of power on the Seashore Electric Railway of Asbury Park, N.J., equipped and run on the Daft system.

After accurately measuring the total power developed by the steam engines that drive the dynamo generators, and apportioning it, by familiar methods, among engine friction, that of the countershaft of the dynamo generator and conductive system—both mechanical and electrical—there remained 26·6 H.P. assignable to 14 cars in operation. A complete record had been kept of the number of passengers per car, which averaged 23, exclusive of driver and conductor. The speed, exclusive of stoppages, had been deduced by averaging an infinity of observations, and the number of trips was a matter of record, as was also the weight of the car. It only remained to calculate from the total weight of a loaded car—using a standard coefficient of traction—moving at the average speed, and assuming it to be running upon a level track, the horse-power equivalent to such work, and it proved to be 1·957. Dividing the total horse-power cited above—26·6—and arrived at by an opposite process, by the number of cars—14—in operation, it will appear that each car was consuming 1·9 horse-power. A more striking confirmation of the compensating influence of gravity could not be imagined than these almost identical results reached by perfectly distinct and dissimilar methods. The most insignificant gradient could not be mounted except by a greater expenditure of power than that quoted, and the only solution is that acceleration on descending gradients balanced the retardation on the ascending, and that all cars were practically working on a dead level. The fact has an important bearing on the dimensions of power station equipments, which need only be proportioned to dispose of the average work of the motors multiplied by their number, but it does not in the slightest degree modify the necessity of every electro-motor being competent for the maximum work that can ever come upon it.

What the effect of this demonstrated principle would be if applied to the 270 steam locomotives of the New York elevated railways, 90 of which stand in reserve burning a certain quantity of fuel uselessly—that is to say, in a present sense—it is surely superfluous to expatiate upon; but when applied to the thrifty electric locomotor the vista it opens is so fair and flattering as to raise suspicion with sober-sided railway financiers and managers that it is more of a mirage than an actual prospect, and heads are shaken dubiously at it. But it is no mirage, and whoever starts first for it will hold the oasis for his own.

NATIONAL ELECTRIC LIGHT ASSOCIATION OF AMERICA.

THE convention of the National Electric Light Association of America opened at Chicago on Tuesday, February 19th. After a welcome to Chicago by the city electrician, Mr. John P. Barrett (in the unavoidable absence of the mayor), the president, Mr. S. A. Duncan, delivered the annual address, which will greatly interest English electricians, to the convention. He said:—

Gentlemen of the National Electric Light Association,—But few of the gentlemen of this country who are commercially connected with the manufacture and distribution of electric light and power, and the apparatus used therefor, are aware that five years ago this month a handful of men met in this city and organised a movement which has grown into the large and powerful organisation of which we are members, and which is in session at the present time.

The industry of electric lighting at that time was carried on with all the enthusiasm which comes with a new undertaking, and with the mistakes which are sure to arise in the commercial introduction of any great industrial agency. The gentlemen engaged therein, strangers to one another, working independently, with no attempt at harmony, with but little knowledge of one another's methods of business, with no established custom or precedent to guide them, came together for the purpose of deriving those benefits which invariably result from the deliberate discussion of those mooted questions which are common to the experience of all electric light men.

To even enumerate the topics which have been discussed at the various conventions of this association, the reports which have been rendered by special committees, the papers which have been presented by recognised experts in the various departments of electrical engineering, and the discussions which have taken place between those well qualified to speak, would consume more time than your president feels at liberty to take for such a purpose from this association. Fortunately, the association is in possession of a complete set of published proceedings from the first convention down to the present time, and these volumes, many hundreds in number, now reposing in the electrical libraries of this country and abroad, testify to the steady and yet rapid growth of the industry and the increased information on the part of the whole electrical fraternity on the general subject of electric light and power. It may be remembered that in the early days of this association the chief question before the electrical fraternity was the then all-important question of arc lighting. The incandescent light had scarcely come into commercial use. No sooner had the questions involved in arc lighting been solved by the natural pressure of public demand than the complicated questions involved in the distribution of incandescent lighting absorbed the attention of the fraternity, and occupied the meetings of this association. Following closely upon the problems involved in incandescent lighting came the question of electrical distribution of power, first for stationary motor purposes and afterward for the purpose of electrical locomotion. This question is to-day, perhaps, the most important one before the electrical fraternity. To say that electrical power is not to-day a success would be to reflect upon the scores of electrical railways now in successful operation in this country, and upon the thousands of electrical motors that are every day commercially serving the wants of man.

We may here profitably consider some figures indicating the growth of the electric lighting and power industry, the increase in the number of central stations, arc and incandescent lamps, electric motors and electric railways now in operation. At the meeting of this association one year ago, it was estimated that there were not less than 4,000 central stations and isolated plants in operation in the United States. From the accompanying statistical table, it may be seen that the number of central station and isolated plants at the August meeting of 1888 was 5,351, and at the present time is 5,747. This shows an increase during the first six months of the year of 1,351 central station and isolated plants, and an increase during the latter half of the year of 716, making a total increase during the year of 2,067 plants. Figuring in percentages, the increase during the first half of the year was 52·3 per cent. in the total number of central station and isolated plants, and during the latter half of the year it was 13·5 per cent., making a total increase for the year of 45·8 per cent. It was estimated a year ago that there were 175,000 arc lamps in daily use in the United States. Six months ago I found upon investigation that there were 192,500. At the present time I find that there are 219,924, making an increase during the first half of the year of 35,201 arc lamps, and during the latter half of the year an increase of 27,424, making a total increase of arc lamps in use during the whole of the year of 62,625. Figured in percentages, the increase the first half of the year shows 20·1 per cent., the second half 14·2 per cent., making a total gain of arc lamps for the year of 34·3 per cent. A year ago it was estimated that there were 1,750,000 incandescent lamps in use in the United States. Six months ago I found that there were 2,142,440. At the present time there are no less than 2,504,490, making a gain during the first half of the year of 392,924, and during the latter half of the year of 361,596, or a total gain for the year of 754,990 incandescent lamps. Figured in per cent., it shows a gain during the first half of the present year of 32·3 per cent.; during the latter half 10·7, a gain during the whole year of 49 per cent.

It is also interesting to notice what the increase in capitalisation has been in electric light companies of the United States during the year. During the first half of the year the increase was $42,210,100; during the latter half it was $27,187,634, making a total gain during the year of $69,397,734.

It is also interesting to note some comparative figures upon the electric railway industry. Six months ago, there were 34 electric railroads in operation in the United States. During the last six months there has been an increase of 19, making at the present time a total of 53. Six months ago there were 83 roads in process of construction. There are 39 less at the present time, making the number of roads now under construction not finished, 44. Six months ago there were 39 electric roads incorporated in the United States upon which construction had not yet begun; at the present time there are 42. Six months ago there were 225 electric cars in operation. Since that time 155 have been put into commission, making, at the present time, 379 cars in operation. Six months ago there were 244 cars under contract but not in operation. This number has increased by 185 during the last six months, making a total of 339 electric cars at present under contract but not running. Six months ago there were 138 miles of single track in operation; during the past six months there has been an increase of 157½ miles, making a total at the present time of 294½ miles of single track in operation. Six months ago there were 189½ miles of single track under contract but not in operation. At the present time there are 273¾ miles of single track under contract but not in operation. It would be profitless for me to draw elaborate deductions from these figures; they tell for themselves the story of prosperity and rapid growth throughout every department of the electric light and power industry.

Acting under resolutions passed at the last convention, the president of this association established a headquarters in the City of New York in charge of the secretary and treasurer on the first day of October, 1888, which action was confirmed by the executive committee on November 19th. From this office has been carried on a voluminous and elaborate correspondence with the whole lighting and power fraternity of this country, not only upon the subject of the work of the various committees of the association, but also in regard to this most important feature, the exhibition of electric light and power apparatus. For the first time in the history of the National Electric Light Association, this has received the prominence which it merits. The exhibit which appears in the other rooms of this building testifies not only to the interest which is shown by the electric lighting and power men of this country in the apparatus which is now before the market, but it also shows the fact that the manufacturers and dealers in apparatus and supplies are willing to put themselves to expense and trouble to bring their wares to our notice in a suitable and proper way, when we are gathered at our meetings. Although this movement originated prior to the last convention, and the correspondence pertaining thereto has been carried on by the New York office, I wish to say that much of its success is due to the admirable and methodical management of the chairman of the executive committee, Mr. B. F. Sunny, of Chicago. We are gathered at the present time, gentlemen, not only for the purpose of seeing an exhibit of the latest forms of electrical apparatus and supplies, but primarily for the purpose of listening to papers and discussions upon all important electrical questions. I will not burden you with a detailed account of these reports and papers and discussions which will come before this body. Some of the subjects deserve special mention. Petroleum for fuel first received attention from this body at its last meeting. At this present meeting several papers will be presented upon this all-important subject. The question of the materials of underground conduits in relation to the insulating materials of cables will also be treated. The mooted question of static charge on underground cables and the attendant puncturing thereof will also be the theme of an elaborate paper. Electric light stations as fire risks will be comprehensively treated by a recognised expert in fire underwriting, who has given especial time and attention to this particular branch of the subject. The question of municipal lighting, which is pressing upon the electrical fraternity to-day, will be the subject of one or two papers, and no doubt of a profitable discussion. The numerous committees of this association have reports to make upon subjects which will be of much interest to all. The committee on underground conduits and conductors has carried on an enormous correspondence with the entire electric lighting fraternity of this country, and it seems eminently proper that the information they have gathered should be presented in this city of Chicago, where the subject of the undergrounding of electric lighting wires has been more practically carried out than perhaps in any other city in the world. This question, which is at present one in which diverse opinions are held by men of equal professional standing, is one which this association cannot afford at the present time to ignore or overlook.

This association is at the present time in a flourishing financial condition. By this we do not mean that we are rolling in wealth, but that we are comfortably able to pay our bills. Since our last meeting the entire membership rolls has gone through a revision, the memberships at the present time being vested in individual names instead of corporations. This has, of course, involved an enormous amount of correspondence, and a vast outlay of time and trouble. It has, however, been successfully accomplished, and at the present time the roll of live, new members testifies to the wisdom of this action. Although the association numbers among its members every gentleman actively interested in the electrical distribution of light and power, it is an undisputed fact that it should contain not less than three times that number. It is believed that the association is now on that "tide in the affairs of men which leads on to fortune." With the proper exercise of care in the management of the association, it is felt that the enormous growth of the industry and the consequent influx of hundreds of men into its ranks will lead to a much greater increase in the roll than there has ever been before. The gain of new members since January 3rd evinces the fact that an interest is being taken in the association by the community at large.

PROFS. AYRTON AND PERRY'S HOT WIRE VOLTMETER.

AT the end of 1887 a modification of the Cardew voltmeter was described at a meeting of the Society of Telegraph Engineers. Instead of measuring the extension of a long straight wire as had been done by Captain Cardew, Profs. Ayrton and Perry fastened a short wire at each end inside a metallic tube, and pulled the wire out of the straight line by one of their magnifying springs fixed at the centre of the wire, and they showed that if the sag of the wire was initially small, sufficient change in the sag was produced by the application of only eight or ten volts at the ends of a wire eight inches long, that when magnified by one of their springs, a complete rotation of the pointer was produced. At that time they gave what they considered the mathematical theory of the instrument, but at the end of a paper on Electrical Measurement, read by them at the Physical Society on February 23rd, they pointed out that in their original investigation they had only taken into account the alteration of the length of the wire due to alteration of temperature, and had neglected the alteration of length due to alteration of stress which occurs with the alteration of sag, under the impression that the working stress in the wire was too small for the alteration of length due to the diminution of stress that occurs when the wire expands to affect the alteration of sag produced by the application of a given P.D. They remark that their having omitted to take into account the effect of the alteration of stress, is the more curious since one of them pointed out in one of the electrical periodicals, in the autumn of 1887, the importance of not neglecting it in the case of telegraph wires, and showed how the compensating action, thereby introduced, enable the dip of a telegraph wire to be made much less in summer than would be possible, without the wire breaking, in the winter, if the simple change of length of wire by change of temperature were alone considered.

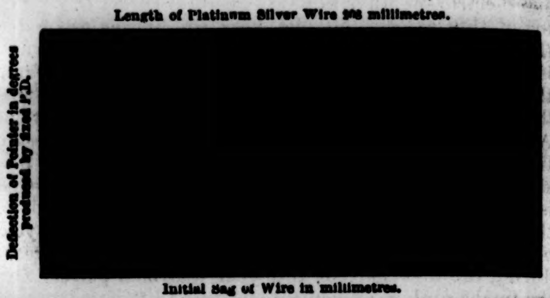


FIG. 1.—EXPERIMENTAL HOT WIRE VOLTMETER.

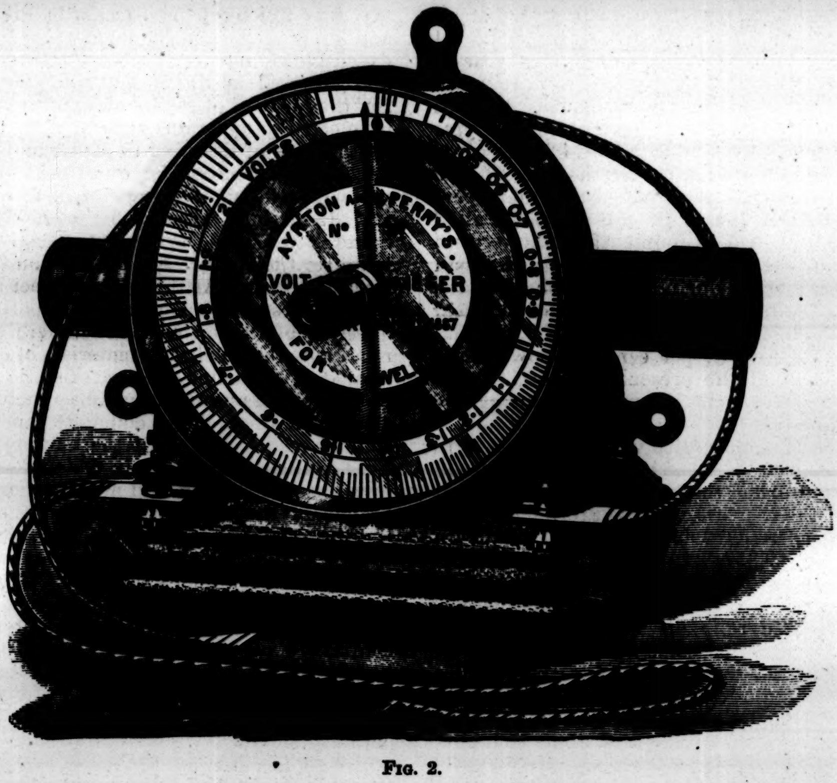


FIG. 2.

In the early part of 1888 they had reason to think that the theory of their instrument, as given by them at the end of 1887, required modifying, and a long series of experiments conducted by their assistant, Mr. Bourne, and the results of which they have since corroborated by a more complete mathematical investigation of their hot wire voltmeter, which they now submit to the Physical Society, show that for each type of magnifying spring with a given initial tension, the deflection of the pointer for a given P.D. applied at the terminals of the instruments varies, as shown by the curve in fig. 1, for different initial sags. The exact shape of the curve depends on the particular type of magnifying employed, and for the initial stress given to it, but in each case the sensibility increases up to a certain maximum as the sag is increased, and then diminishes again.

Another interesting fact brought out by this investigation is that for a tube containing definite proportions of iron and copper the temperature error of the voltmeter, that is, the motion of the zero and the change of the deflection for a given P.D. when the instrument is warmed up as a whole, varies with the initial sag. But this result the inventors regard as an advantage, as it supplies them with a delicate final adjustment, so as to reduce the temperature error to practically nought.

By utilising the results of this investigation they have at length been able to construct voltmeters of this type with a surprisingly large sensibility and small temperature error. The one shown in fig. 2 has been constructed to measure the alternate P.D. at the terminals of the secondary coil of a Thomson and Houston welder, and which they find is between 1 and 2 volts. A P.D., direct or alternate, of 2·16 volts gives one complete rotation of the pointer over a scale 6 inches in diameter divided to one-hundredth of a volt. The extreme sensibility of this hot wire voltmeter was shown at the meeting of the Physical Society, by using it to measure the E.M.F. of an accumulator, and the fall of the P.D. at its terminals when the accumulator was sending a current. The E.M.F. of the accumulator used was shown by the hot wire voltmeter to be 2·07 volts and the P.D. fell to 2·03 volts when the current sent, as measured by one of their ordinary spring ammeters, was 10 ampères. Hence the resistance of the accumulator was

$$\frac{2{\cdot}07 - 2{\cdot}03}{10} \text{ or } 0{\cdot}004 \text{ ohm,}$$

a result obtained almost instantaneously.

We understand that although Profs. Ayrton and Perry have been turning their attention especially to the construction of very sensitive low reading voltmeters for measuring a direct or alternating P.D., the Acme Works construct the hot wire voltmeter to read to any required voltage.

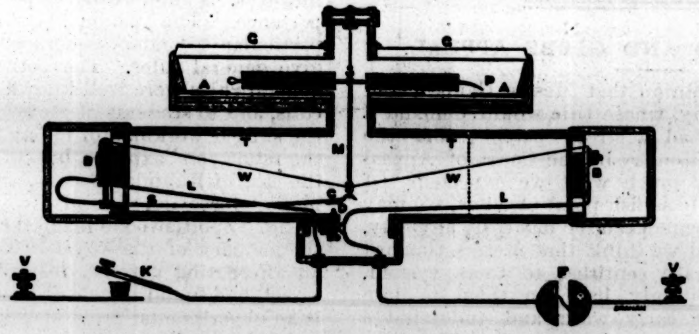


FIG. 3.—HORIZONTAL SECTION OF HOT WIRE VOLTMETER.

Fig. 3 shows a horizontal section of the instrument as at present constructed by the Acme Works. In the original instrument the pull of the magnifying spring, M, was counterbalanced by the pull of the platinum silver wire, W, W, attached to the blocks, B, B, but to save space both these pulls on the present instrument act in the same direction, and are counterbalanced by the flat spring, S. Hence as the wire stretches the magnifying spring, M, is stretched, and the pointer, P, to which a number of fine hairs are attached to introduce damping without solid friction, rotates. The flat spring is not only introduced to enable the depth of the instrument to be diminished by twice the sag of the wire, but to enable a particular arrangement of fuse to be employed. In the ordinary Cardew instrument, with its two yards length of wire, the introduction of a short fuse which will melt with a current too small to damage the instrument does not seriously increase the resistance or diminish the sensibility; but in Professor Ayrton and Perry's hot wire voltmeter, which contains only 8 inches of wire, the introduction of such a fuse would diminish the sensibility, and it is practically impossible to diminish the length of the fuse in proportion to the length of the working wire, as the conduction of heat by the metallic blocks to which an extremely short length of wire is attached prevents its quickly melting. Hence they employ a fuse, F, of such a diameter that it would require a far larger current to melt it than would damage the instrument, and they arrange in addition a platinum tipped screw, D, so that when the wire, W, W, stretches by any prearranged percentage beyond the amount it stretches for the maximum safe P.D., the platinum tip, C, of the flat spring, S, comes into contact with the screw, D, and the working wire is short-circuited. The circuit is then temporarily completed through the lead, L, to the left of the flat spring, S, and the fuse, F, when the current increases and the fuse melts without damage to the instrument. With this device they find that the fuse may be thick, and therefore have but a small resistance compared with that of the working wire, and yet the sudden application of a P.D. five or six times as great as the maximum P.D. the voltmeter is intended to measure, melts the fuse without damaging the working wires. For clearness the fuse, the key, and the terminals, V, V, are shown detached from the instrument, but they are in reality in the base, as seen in fig. 2.

ELECTRIC LIGHTING APPLICATIONS TO THE BOARD OF TRADE.

THE application which the House-to-House Electric Light Supply Company is making to the Board of Trade differs materially from the application of which it gave notice some months ago, and from the application of some other companies competing with it in the same area. In November last the directors advertised their intention to apply for a "Provisional Order" to light certain portions of Kensington, which were set out in detail. They now announce that they are applying not for a provisional order, but for a "licence," which is an authority of a much more limited character. This change may or not be due to the public discussion in various forms (and especially in reference to Kensington) during the last few months of the question of electric lighting; but having regard to the unsettled state of the subject, the modification seems wise. In place, also, of a long list of streets, gardens, mews, and other places which they previously gave, they now simply give the foregoing brief description of the area of supply under consideration, which may be useful to some of our readers:—"All the streets and thoroughfares in the parish of St. Mary Abbotts, Kensington, comprised within the area bounded on the south and west by the parish boundary, and on the north and east from the point where the Kensington Road crosses the boundary, by the Kensington Road to the Earl's Court Road, and from there by the Earl's Court Road to the Cromwell Road, and from there along the Cromwell Road to the Gloucester Road, and Cranley Gardens to the southern boundary of the Parish." The other point worth noting is that whereas other companies who gave notice of applications for power to supply Kensington asked for authority to place their wires and mains "in, through, *under*, over, along, and across" streets, this company propose to run their wires not *under*, but only "in, over, along, or across" the thoroughfares.

ELECTRIC LIGHTING IN SHEFFIELD.

THE electric light station of the Sheffield Telephone Exchange and Electric Light Company, Limited, contains three 50-light Thomson-Houston 10 ampère current dynamos, running at present more than 100 arc lights, the demand for which is steadily increasing.

The machines are driven by a compound condensing engine working on to a countershaft. A shunt-wound machine is also run off the same countershaft for charging secondary batteries, the current from which is being used for local and office purposes.

The company has just completed extensive structural alterations, by which the size of the engine and machine rooms, and the capacity for output, have been more than doubled. An additional 100 lbs. pressure steel boiler has been laid down within the last few weeks, together with a new high pressure horizontal condensing engine.

The engine is employed to run a Mordey Victoria alternator of 35,000 watts, the exciter being coupled to the shaft of the alternator. The current is transformed in the usual way.

Already important orders for the incandescence lights are in hand, and places are being wired that will absorb the greater part of the output of this machine. and it is anticipated that the plant for incandescence lighting will be increased before the next autumn, and for which the foresight of the directors has provided ample room for development.

THE GAULARD AND GIBBS APPEAL.

WE were never of opinion that Messrs. Gaulard and Gibbs, or their company, whose title would demand a special supplement, had a strong patent; and the judgment given last Monday by the Court of Appeal is, on the whole, very much what we expected. Of course, from the purely selfish point of view, we may feel glad that transformers can be made by anybody, but on the other hand we think that Messrs. Gaulard and Gibbs were morally entitled to their system, and that it is exceedingly hard on them to lose the benefits of their early work and indomitable perseverance.

We discussed the case at some length in our leading article of July 13th, 1888, so it is unnecessary to go over any of the same ground again. Mr. Justice Kekewich's main objection to Gaulard and Gibbs's patent was that the specification was badly drawn. The question whether Gaulard and Gibbs invented the system that is now coming into fashion so quickly was not decided at all.

The gist of the judgment, whose text will be found in another column, is that Gaulard and Gibbs originally thought the whole virtue of their system lay in the particular forms of secondary generators they described. Finding their patent attacked in 1888 they might have kept the patent as originally intended, that is to say, limited to cover only the particular forms of secondary generator described. The patent might then have been almost unassailable, but it would have been of no value, because the secondary generators now in use might not have come under it. Instead of doing this, the patentees amended their specification so as to cover the combination of any high tension alternating current dynamo with long thin leads, and any suitable secondary generators for the purpose of distributing electricity. The result, according to the Court of Appeal, is that the amendment has enlarged the patent, and that it therefore renders it hopelessly bad in point of law.

We do not know if the patentees will go to the House of Lords. If they do they may argue as follows: The first and second claims were originally for the broad combination, and the third claim was for the particular form of secondary generator. In amending we merely struck out the claim for the particular form of apparatus, and did not in any way interfere with the scope of the other claims.

A great deal of the difficulty in the question really arises from the nature of the invention itself. It is so very obvious when once known, that people are apt to suppose it was known all along. All that was wanted in 1882 to make the whole invention flash before the mind of any competent electrical engineer, was the mere suggestion "Distribute with high tension and reduce by induction coils." If Messrs. Gaulard and Gibbs had taken out a patent with a specification occupying about ten lines, they would have had an invaluable patent. They may, of course, still argue that their specification contains that idea, and that the long description of apparatus was necessary, partly because they thought their apparatus good, and partly because the skilled workman might not know how to make induction coils. To make good secondary generators attention to certain points is necessary: In the first place, the core must be laminated. It was argued that the necessity for the lamination of cores was well known, but, as a matter of fact, Ruhmkorff cores were laminated, not to avoid heating, but to prevent Foucault currents in them, so that the iron would demagnetise very quickly, and the spark given would therefore be long. As the lamination is for a different purpose, the skilled workman would not naturally employ it and, in fact, prior specifications almost invariably show solid cores. In the next place, the volume of the primary and secondary should be approximately the same. In Ruhmkoff coils the secondary is always enormously greater than the primary. This, however, is not really a point of very much importance. The patentees show how to wind the particular secondary generators described, but do not give general rules. The petitioners argued that the general rules were well known to makers of induction coils, and to students of Maxwell. We have no doubt the skilled workman of to-day has studied Maxwell at the ratepayers' expense, but the law does not hold in the case of Ruhmkorff coils, as the secondary electromotive force depends also on the suddenness of the break. Spottiswoode made the experiment of exciting the primary of the Royal Institution coil by means of an alternating current, instead of a make and break direct, and found the spark shorter and thicker. This is an experimental proof of what we have been saying. So far from the laws of secondary generators being quite clear in 1882, we have reams of matter published recently to show how the secondary electromotive force depends on the primary. It is true, however, that before 1882 anyone like Sir W. Thomson would need nothing more than the bare suggestion mentioned already to enable him to make secondary generators not only as good as Gaulard and Gibbs, but as those now in use. On the other hand, a glance at some of the forms by various makers, as described in these columns, shows that even now the main principles are not always understood.

The whole position is this: A patentee invents *c* to be used with A and B. He describes the combination, and describes *c* at length. He then claims the combination of A, B and C, and also separately claims *c*. It is then found that c or C, or in fact, any form of C will do, so they disclaim little *c*, and fall back on the combination claim covering big C, or secondary generators generally in combination with A and B. Of course, if this is an enlargement, the patent is "hopelessly bad," but will the House of Lords hold it to be an enlargement? We sincerely hope the patentees will not go to the House of Lords rashly, as far too much money has already been lost by litigation.

The Court of Appeal seems to regard Messrs. Gaulard and Gibbs as the real inventors of the system, and this is important to some extent, as an acknowledgment of the credit due to them; but it has more commercial importance in another direction.

From our other columns it will be seen that the assignees of Jablochkoff's English patent are collecting royalties from users of secondary generators, and that several important companies have agreed to their terms. This is not a little surprising, as Jablochkoff's patent appears not to be for distribution of energy at all, but for an unworkable method of "subdividing the electric light." If the assignees bring an action against anyone, they will have to face the Court of Appeal's decision that Jablochkoff did not invent the Gaulard and Gibbs system. If no new evidence is brought forward, and the Court of Appeal has decided, after evidence on Jablochkoff's specification, that Gaulard and Gibbs invented distribution by transformers, and therefore that Jablochkoff did not, it will be a question whether a court of first instance will be in any way bound by this decision.

The next question will be whether, if Jablochkoff invented something with one object in view, he may not be entitled to a monopoly of the use of the invention, whatever the object may be. In answer to this, it may be argued that Jablochkoff's patent was no use till Gaulard and Gibbs showed how to distribute electrical power by induction coils. This question is rather complicated. The Court of Appeal has recently held that Cheesbrough's patent is good, though it has also held that there were no incandescent lamps till Edison showed people how to make filaments, so that Cheesbrough's invention was of no utility till after the publication of Edison's.

Of course, the United Electrical Engineering Company is not trying to hamper trade by any monopoly; it is merely collecting a small royalty, which is not a heavy burden on the industry.

The consideration of all these actions only leads us to the conclusion that, on the whole, patents are a mistake, and productive industry would, in the long run, flourish more if there were no monopolies.

NOTES.

Electric Lighting at Sunderland.—The electric light has been adopted in the Chain Cable and Anchor Testing Works of the River Wear Commissioners at Sunderland. Hitherto the testing of cables, &c., has been carried out by daylight, but an enormous increase of work has necessitated a great deal of overtime. The electric light was first used in a fixed form, seven lamps of 300 C.P. being employed; but this was found to be scarcely satisfactory, so that portable lamps of 16 C.P., attached to the caps of the examiners, were substituted. Connection is made with the generator by means of flexible cables, which allow the men to move within a radius of about 20 feet. This is said to be the first instance of portable lamps being supplied with current direct from the dynamo. Sunbeam lamps are employed, and the dynamo is one of Messrs. Clarke, Chapman and Parsons.

Ship Lighting.—There was launched on Saturday last, from the Fairfield Shipbuilding and Engineering Company's yard, a steel paddle steamer to the order of Messrs. G. and J. Burns, and intended for a new daylight service about to be inaugurated by them between Ardrossan and Belfast. Although the *Cobra* is intended for daylight service, she will be fitted with a most complete installation of electric light.

Cork and the Electric Light.—At a meeting of the Cork Corporation on March 2nd a report of the special committee on electric lighting was read. It recommended that the committee be authorised to invite tenders from the several electric lighting companies for lighting the city by electricity, and to report thereon to the council. A discussion of a particularly Irish character followed the reading of the report, and in the end it was agreed that the recommendations of the committee be postponed until the city engineer brings up a report to the committee as to the cost and results of electric lighting in several cities and towns.

Greenwich and the Electric Light.—The Greenwich District Board of Works met specially on Wednesday to consider an application made by the London Electric Supply Corporation, Limited, under the Electric Lighting Acts, for a Provisional Order for the supply of electricity in the district of the board, a draft of which scheme had been deposited with the Board of Trade. Mr. Knight moved that the matter be referred to the district committee, as the company did not wish to supply that district, and had made arrangements with the railway company to carry the mains away. Mr. Foy thought there should be longer time to consider the matter. The clerk thought that the company would not be prejudiced by delay, and in his opinion it was necessary that the committee should have the services of an electrician. He suggested that a meeting be held a fortnight hence, and that an electrician be consulted. The clerk's advice was adopted. The clerk then reported that the London Electric Light Supply Corporation had excavated roads in Deptford and commenced to lay down mains, but he had stopped them, as they were blocking the thoroughfares. The Corporation ought to have done the work at night, and in the way prescribed by the board's officers; but instead of so doing they had put the matter in the hands of two gentlemen who seemed to have had no experience whatever of digging trenches and laying pipes. They employed 100 men out of the streets, and the work was done in a most unworkmanlike manner. The manager and secretary of the Corporation had expressed their regret that any irregularity had been committed, and had given orders for nothing further to be done at present. It was obvious that in putting down these pipes the Corporation were attempting to steal a march on the public, and to get as many of their mains laid as possible. It was then agreed that the clerk should give notice to the Corporation to undo all they had done.

The Electric Light and Ice Palaces.—The wonderful Ice Palace, which is the great feature of the Winter Carnival in Montreal, is at night illuminated inside and out by the electric light. In a similar manner the electric light will be largely used at the three days' Ice Carnival at the Albert Hall next week. The effect of this luminant upon solid masses of glittering ice is exceedingly brilliant and beautiful.

London and the Electric Light.—St. Olaye's District Board of Works has decided to take no action with regard to electric lighting. The opposition to the electric lighting scheme in St. James's raised by Mr. Keevil has subsided. St. George's (Hanover Square) Vestry has adopted a recommendation of the Electric Lighting Committee to refuse altogether the application for consent to a provisional order made by the Chelsea Electricity Supply Company. Consideration of applications from other companies has been adjourned.

Electric Lighting at Okehampton.—On Monday, at a meeting of the Okehampton Town Council, a letter was read from Mr. H. Geen, builder, of Fore Street, offering to light that thoroughfare with 16 C.P. incandescent electric lights for 30s. per lamp per annum. If desired, the area could be extended. A letter was also stated to have been received from Mr. W. Wood, who said that he had available water-power, in close proximity to the town, to supply the whole of the lamps with the electric light at 28s. per lamp per year. A third communication was received from the gas company applying for permission to break up the roads in order to supply the electric light. A motion was proposed to refer the various applications to the lighting committee, but to this there was an amendment deferring the consideration of the whole subject for six months. Eventually the original resolution was carried by a large majority.

Ealing and the Electric Light.—The *West Middlesex Standard* understands that a local company for the supply of the electric light in the town of Ealing is now in course of formation in connection with the Maxim-Weston Electric Company's system, which system has already been adopted at the offices of the West Middlesex Printing and Publishing Company.

Electric Lighting for Nottingham.—At the meeting on Monday of the Nottingham Corporation, a letter was read from Messrs. Maples and McCraith, of which the following is an abstract: —"We are instructed by the Nottingham Electric Light and Power Company, Limited, a company which has just been formed with a registered capital of £100,000, to ask for the consent of the Town Council to the putting down of underground wires in the town of Nottingham for the purpose of the supply of electric light and power. The area proposed, speaking generally, is the Nottingham Park and the lace market, with some streets adjoining thereto. Our clients, the company, as they are asking for a concession of a particular area, will be prepared to submit to compulsory powers in that area. The company will throughout the matter be desirous of acting in thorough unison with the Town Council and its advisers." The Mayor said the application made by the Electric Light Company was of so important a character, that he thought it advisable to move a resolution in reference to it. It was as follows: That the following members of the council, namely, the Mayor, Mr. Ald. Barber, Ald. Sir John Turney, Mr. Ald. J. P. Ford, Mr. Ald. Gripper, Mr. Ald. Cropper, Mr. Councillor Sands, Mr. Councillor Pullman, Mr. Councillor Robinson, Mr. Councillor Brewster, Mr. Councillor Fitzhugh, and Mr. Councillor Fraser be, and hereby are, appointed a committee to consider an application from the solicitors to the Nottingham Electric Light and Power Company, Limited, for the consent of the Town Council to the above-named company supplying a given area in the borough with the electric light and power, and to advise the Town Council as to the propriety of giving such consent, and the terms and conditions upon which such consent should be given, and that the whole matter with reference to the lighting of the borough or any part thereof by electricity be referred to the same committee for consideration. Mr. Wootton seconded the motion, which was carried *nem. con.*

Transformer Patents.—To those interested in the transformer question we would suggest a careful study of Jablochkoff's patents, Nos. 836 of 1876 and 1,996 of 1887. In the first we believe he describes a form of electro-magnet with a complete magnetic circuit. The other is that upon which the United Electrical Engineering Company claims royalty.

A Pressing Need.—A singular illustration of the need of telegraphic communication between lighthouses and the mainland is afforded by a recent incident near the Casquet lighthouse. A large vessel was discovered the other day by an Alderney fisherman sunk in 18 fathoms of water, only her main-topmast-head appearing above water. How she came to grief, or what became of her crew, is not known, but it is a suggestive circumstance that although the men in the lighthouse had been aware of the wreck for some time they had no means of communicating with the shore. Had they possessed means of telegraphing to Alderney it is possible enough that the crew might have been saved, and at all events they could have summoned the authorities to the early recovery of the vessel and its removal from a position dangerous to other ships.

The Central London Subway.—Notice of motion has been given in the House of Commons by Mr. Bonsor, Mr. Gainsford Bruce, and Mr. John Kelly that the Bill empowering the construction of a subway between Piccadilly and Holborn Circus for electrical trains be read a second time that day six months.

The "Peral."—The Spanish submarine torpedo vessel *Peral* was floated in the dock of the Carraca Arsenal, near Cadiz, on Wednesday. The first trial began successfully, says the *Standard*—the boat was very manageable at first, and her speed even surpassed the expectations of the inventor. But the trial had to be suspended, because the force of the current caused the submarine boat to run aground in a narrow channel. She was towed off to the Arsenal of San Fernando, where her defects will be made good for the official trial to take place before the end of the week.

West African Cables.—We hear that the ss. *Silvertown* was timed to leave Greenhithe yesterday for the West Coast of Africa. We wish all on board a successful trip and a safe and speedy return.

Electric Traction.—Next Wednesday has been appointed by the directors of the Series Electric Traction Syndicate for a press view of the tram line at Northfleet, which is being operated by the syndicate. We trust that in this there may be found the elements of success which have apparently been lacking in previous schemes for electric locomotion.

Science in India.—The Mohammedan Literary Society of Calcutta has celebrated its 25th year of existence by the publication of a sketch of its history, which presents much that is interesting. This sketch glances at the labours of the society in promoting, by conversaziones, monthly meetings and lectures, the study of such subjects as the uses of history, the origin of newspapers, commerce, arts, agriculture, electricity and the electric telegraph, combustion, and so forth.

The Copper Ring.—In spite of the heroic efforts of the Paris syndicate, the great copper combination appears to be among the breakers, says the *Globe*. For several days there have been signs of coming collapse, culminating in a semi-panic when it became known that the metal was being offered so low as £55 a ton. If sold at this price, the enormous stocks accumulated by the syndicate would involve a loss of many millions, and utterly break down the gamble. Nor does holding on promise a way of escape from ruin; stocks are increasing at an alarming pace, and unless some strong impetus can be imparted to demand, the "ring" must be crushed at no distant date. A significant fact in connection with the copper question is the suicide of M. Denfert Rochereau, the manager of the Comptoir d'Escompte.

Electric Wire Casings.—Mr. Samuel Elliott, of Newbury, who is one of the largest manufacturers of wood casings, has just issued a new edition of his catalogue, No. 6, which contains a number of new registered designs, and is therefore worth the notice of electrical engineers and others.

Cheap Motor for Small Powers.—Messrs. Cuttriss & Co., of Leeds, whose name has been identified for some years with the manufacture of small electric motors, have recently turned their attention to the production of a strongly-built, reliable and cheap motor for comparatively small powers, suitable for use on electric-lighting circuits, believing that there are many uses to which such machines can be put, and that with the rapid increase of central stations for the supply of electrical energy, there will be a large demand for them. By making the field magnet of a single casting of the best metal, low cost with good efficiency is attained, and although in some cases the weight may be objectionable, in others it is a matter of no account, and it simply becomes a question for the manufacturer whether it is commercially more economical to make the field magnet of cast or wrought iron. The cases where lightness is a consideration are met by the substitution of a wrought-iron field magnet of special construction. The motors are being introduced in three sizes, namely: $\frac{1}{8}$, $\frac{1}{4}$ and $\frac{1}{2}$ horse-power. The average result of several tests made with one of the $\frac{1}{2}$-H.P. motors is said to be 76 per cent.

Electrical Trades' Directory.—The seventh yearly edition of the directory issued at the office of the *Electrician* is published with its title altered, so as to be more comprehensive, and to indicate more accurately the aim of its publishers to make it a handbook for the electrical profession, both scientific and practical. The book is much improved in many respects, and is increased in size from 400 pages to about 600. We would, however recommend the suppression of many of the portraits, which can only excite the risible faculties of those who know the gentlemen who are supposed to be represented pictorially as well as biographically.

South Africa.—Under the title of "South Africa, and how to reach it by the Castle line," a very useful little book has been written by Mr. E. P. Mathers, F.R.G.S., and published on behalf of the Castle line of Royal Mail Steam Ships by Messrs. Waterlow and Sons. It is intended as an easily read but comprehensive guide to the land of gold and diamonds for the use of passengers by these steamers; but its statistical and other information will be found valuable by all who take any interest in the progress of that continent.

The Blackpool Tramway.—The *Blackpool Times* speaks thus of the electric tram line:—"The electric tramcar system is perhaps not so highly appreciated by the people of Blackpool as it ought to be, and therefore it is not surprising that the company should give the public an occasional 'tit-for-tat.' The Britisher is, however, an enduring animal so long as his 'shekels' are not touched. Once dip into his pocket, and the 'animal is up.' Three or four hundred persons from South Shore who travelled northwards recently to attend a concert, did not feel any excess of admiration for the tram company when they learned, at truly the eleventh hour (p.m.) that the promised cars would not be run, 'owing to the weather;' but we fancy that more than that number are likely to protest against any alteration in fare without something like notice being given of the change. The alteration is certainly not much—only 100 per cent. increase—from 1d. to 2d. for riding outside; but such an alteration is not calculated to augment traffic returns."

Electric Lighting at Morecambe.—At a special meeting of the Morecambe Local Board, Messrs. Andrews and Preece, electricians, Bradford, together with their solicitor (Mr. Darlington), attended in order to furnish any necessary particulars with reference to the notices issued by them of their intention of applying to the Board of Trade for a Provisional Order enabling them to supply electricity for lighting purposes within the Morecambe Local Board district. They stated that in the event of the board not opposing their application they were willing to fit up a central station, to lay all wires underground, and to supply the electric light for ordinary domestic purposes at a charge of 7d. per Board of Trade unit, equivalent in price to ordinary gas at 4s. per 1,000 feet. For public lighting they were prepared to supply twelve 2,000 candle-power arc lamps, 100 yards apart, and at an elevation of 35 feet from the ground, for £25 per lamp per annum; or for 100 nights during the season at £10 per lamp, being 10s. each lamp per night. Six lamps for the same period would cost £11 each. In winter they could substitute incandescent lamps for street lighting at the same price as for domestic purposes, the expense of a 32-candle lamp of that description being estimated at from 28s. to 30s. per year, the cost of inside fittings to be borne by the householder or owner, as in the case of gas fittings. The details of the scheme were discussed at considerable length, and at the close the board thanked the firm for the information they had furnished, and promised to carefully consider the question.

Melbourne Exhibition.—We notice that Messrs. Gent & Co., of Leicester, have received a first-class award at Melbourne Exhibition for their exhibit of electrical apparatus.

A Correction.—Mr. T. W. W. Melhuish, Assoc. M. Inst. C.E., whom we thank for his courtesy, writes as follows from Vienna:—"In your translation of Dr. Waltenhofen's paper describing the insulation tests made on the electric lighting installation in the new Burg Theatre, Vienna, is a slight mistake, nearly at the bottom of page 204 of the ELECTRICAL REVIEW for February 22nd, 1889.

$$\text{Instead of}\quad \frac{1{,}000 \times 500}{1{,}000 + 500} = 333 \text{ ohms,}$$

$$\text{should be}\quad \frac{1.143 \times 500}{1{,}143 + 500} = 348 \text{ ohms.''}$$

City and Guilds of London Institute Old Students' Association.—A general meeting will be held on Wednesday, March 13th, at the Technical College, Finsbury, E.C., at 7.45 p.m., when the following paper will be read: "Theory of the Chamber Process" (in the manufacture of sulphuric acid), by Dr. G. T. Moody (member). In this paper an account will be given of the various explanations which have been put forward from time to time to throw light upon the formation of vitriol in the "Chamber Process."

The March of Education.—We can vouch for the genuineness of the following answer to the question set in a general intelligence paper, What do you understand by physics, electricity, and magnetism? "Physics is pills and things; electricity is the telegraph wires; magnetism is what you take in connection with rhubarb."—*St. James's Gazette.*

Journalistic Enterprise.—During the convention of the National Electric Light Association at Chicago last month, the *Western Electrician* published daily issues, reporting fully the proceedings of the previous day. This was no light undertaking, and we congratulate our contemporary upon the success with which it was carried out.

The Institution of Electrical Engineers.—On Thursday, March 14th, there will be an ordinary general meeting at 8 p.m., when there will be a discussion on "Some electrical lighting central stations in Europe, and their lessons," by Prof. George Forbes, M.A., F.R.SS. (L. and E.) member.

Barnet Gas Company.—The chairman of the Barnet and District Gas and Water Company told his shareholders the other day that the electric lighting of Barnet had made a "little difference" to them, but he did not seem to regard the competition afforded by the new light as being very serious. We should like to think that he will one day find himself mistaken.

The Heisler System.—Reference is made in our correspondence columns to the Heisler system of lighting in series. Here are a few interesting particulars regarding the system:—The Heisler Electric Light Company ($200,000), the St. Louis Illuminating Company ($100,000) and 36 central station plants in all parts of America represent a capital of, at least, $1,000,000. The business of the St. Louis Company is conducted on a basis entirely different from that of the old systems, as its operation is not confined to the surroundings of the station, but extends to any point where there is a demand for electric light, irrespective of the distance.

Phonographing Niagara.—It is said that Col. Gouraud, Mr. Edison's representative in England, contemplates the experiment of phonographing the Falls of Niagara, with a view, first, to transporting the roaring of the waters to Westminster to complete the already very realistic representation of the Falls in "Niagara in London." It is further stated that Edison has asserted the practicability of the idea. We very much fear that both Col. Gouraud and Mr. Edison are credited with hair-brained ideas for which neither is responsible.

Lead-Covered Cables.—The information gained by Professor George Forbes concerning the lead-covered cables used in connection with the Berlin central station is somewhat alarming. We shall doubtless hear from the manufacturers of these conductors reasons for their rapid deterioration, with suggestions for its prevention, or, at least, for securing a longer period of service than three years. We could ourselves point to several instances in which lead-covered wires have served their purpose for a greater length of time than that mentioned by Prof. Forbes.

NEW COMPANIES REGISTERED.

Nottingham Electric Light and Power Company, Limited.—Capital £100,000, divided into 9,900 ordinary and 100 founders' shares of £10 each. Objects: To establish and carry on in Nottingham, or within a radius of five miles thereof, works for the production, transmission and storage of electric, magnetic or other force. An agreement with Charles James Cox, Leonard Lindley, Joseph Wright, and J. W. McCraith will be adopted. The signatories, who are all of Nottingham and its vicinity, are: L. Lindley, 4 founders' and 20 ordinary shares; R. Birkin, 2 founders' and 20 ordinary shares; G. Blackburn, 2 founders' and 20 ordinary shares; J. Wright, 3 founders' and 20 ordinary shares; J. T. McCraith, 2 founders' and 20 ordinary shares; C. J. Cox, 4 founders' and 20 ordinary shares; W. Lambert, 2 founders' and 20 ordinary shares; R. Halford, 2 founders' and 20 ordinary shares; E. Goldschmidt, 2 founders' and 20 ordinary shares; J. W. McCraith, 4 founders' and 20 ordinary shares. The signatories are to appoint the first directors, qualification, 25 shares or £250 stock; remuneration, £400 per annum, and 10 per cent. of the net profits after providing for the payment of 7 per cent. per annum dividend, to be divided as they may determine. Registered 27th ult., by R. Jordan, stationer, Chancery Lane.

Clamond Lighting Agency, Limited.—Capital £1,000 in £1 shares. To purchase the agency of Richard Oakley of 14, High Holborn, ventilating engineer, for the sale of the "Clamond Light," and to carry on the sale of every description of illuminants, whether produced by electricity, gas, or oil. Signatories (with 1 share each): R. B. F. Passmore, 59, Flaxman Road, S.E.; W. Holmes, 166, High Holborn; Hy. Marson, 63, Dante Road, S.E.; C. W. Brown, Friern Park, North Finchley; E. Marks, 8, Grenville Road, Hornsey Rise; W. H. Johnson, 60, Chancery Lane; H. Bond, 68, St. Mary's Hill, Hornsey. The signatories are to appoint the first directors. Registered 27th ult. by Johnson & Co., 60, Chancery Lane. Registered office, 14, High Holborn.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Railway Automatic Electric Light Syndicate, Limited.—An agreement of 14th February provides for the purchase by the company of the interests of D. H. Davies, John Tourtel, J. E. Spegnoletti, and Joseph Crookes, in the letters patent, No. 8,206, of 1887, and provisional protection, No. 5,201, of 1888, relating to apparatus for effecting by insertion of a coin the production of electric light for a certain time. The purchase consideration is £5,350, payable £350 in cash, and the balance in fully paid shares.

Kensington Court Electric Lighting Company, Limited.—The annual return of this company, made up to the 18th ult., was filed on the 26th ult. The nominal capital is £10,000 in £5 shares, the whole of which are taken up and are fully paid.

Taunton Electric Lighting Company, Limited.—The annual return of this company, made up to the 18th ult., was filed on the 27th ult. The nominal capital is £10,000 in £5 shares; 954 shares have been allotted, and of these 664 are considered as fully paid. Upon 280 shares the full amount has been called, and upon the remaining 10 shares £3 per share has been called. The calls paid amount to £1,430.

Laurence, Paris and Scott, Limited.—The statutory return of this company, made up to the 28th December, was filed on the 10th January. The nominal capital is £30,000 in £10 shares; 300 shares are issued as fully paid, and 905 shares have been subscribed for; £5 per share has been called upon 900 shares, and £10 per share upon 5 shares. The calls paid amount to £4,325, and unpaid to £225.

Rees's Miners' Patent Safety Electric Lamp Company, Limited.—The statutory return of this company, made up to the 27th December, was filed on the 25th ult. The nominal capital is £50,000 in £5 shares, but the 7 shares subscribed for at the time of registration are all at present taken up, and upon these no call has been made. Registered office, 8, Old Jewry.

Sheffield Telephone Exchange and Electric Light Company, Limited.—The statutory return of this company, made up to the 22nd January, was filed on the 16th ult. The nominal capital is £60,000 in £10 shares, the whole of which are taken up. Upon 923 shares £4 per share has been called, and upon 3,077 shares £2 per share has been called; the calls paid amounting to £9,726, leaving £120 unpaid; 2,000 shares are considered as fully paid, and the sum of £6,154 is considered as paid upon 3,077 shares.

CITY NOTES, REPORTS, MEETINGS, &c.

The Anglo-American Brush Electric Light Corporation, Limited.

THE directors beg to submit to the shareholders their report and statement of accounts for the year ended the 31st December, 1888.

In view of the fact that since the date of the last general meeting two interim reports have been issued to the shareholders, the directors consider that the usual *resumé* of the year's work admits of some curtailment in this instance, and they now confine themselves chiefly to a statement of the present position of the corporation, and to an explanation of the yearly accounts.

In the special report of the 18th July last, the directors explained in some detail the circumstances attending the litigation with the Edison and Swan United Electric Company, in regard to incandescence lamp patents, and reported the decision which Mr. Justice Kay had given in favour of the corporation on the Edison patent. The interim report of the 3rd October last contained a general statement of the position and prospects of the corporation at that time, and of the work accomplished during the first nine months of the year.

The directors are glad to be able to announce that the expressions of confidence with regard to the future of the electrical industry contained in their previous reports, are fully borne out by the progress effected during the past year. An extensive and more genuine demand for electric light and power has made itself evident, to the great benefit of the industry generally, and to the corporation individually, as will be seen from the satisfactory character of the accounts now presented of the corporation's affairs.

It is now generally admitted that the amendment of the Electric Lighting Act of 1882, which extends more favourable terms to the electrical contractors, and thus justifies the investment of capital in central installations for the supply of electric current, will produce highly beneficial results. As a matter of fact, although only a few months have elapsed since the Amendment Bill, introduced by Lord Thurlow, became law, considerable impetus has already been given to the business, and there is now much greater activity in all branches of the industry. The improvement in the general position of the corporation which has followed upon the revival of business in this direction is, however, not yet exhibited in the accounts now submitted, as the orders which have been received in connection with the supply and erection of plant for central stations are still in progress. The marked improvement, which is seen from the accounts, is due almost entirely to the growth of the ordinary business.

There are also indications that the amendment of the Electric Lighting Act will have a salutary effect in other directions, and by inspiring renewed confidence, tend to establish a better understanding among the various electrical manufacturers and contractors. United action, where common interests are involved, is greatly to be desired, and a diminution of the unhealthy competition which has prevailed during the recent depression, is necessary to enhance the profits of the business. The formation of an Electrical Trades Section of the London Chamber of Commerce, affording, as it does, opportunities to the principals in the various electrical firms for discussing common interests, is a step in these directions.

The result of the past year's work is, under all the circumstances, highly satisfactory. As compared with the previous year, the volume of business shows an increase of about 38 per cent., and the gross profit an increase of 70 per cent., while the standing charges have increased by only about 7 per cent. The net balance of profit, after providing for depreciation and bad debts, is £12,885 4s. 9d., which is equal to more than 5 per cent. upon the entire capital of the corporation. It is to be remarked that this profit has been earned almost entirely upon the ordinary transactions of the year, and does not include the profit accruing from the central station work now in hand, and that there are still other important fields from which the corporation are able to derive revenues. The shareholders will therefore recognise that the business of the corporation is now not only established on a reliable profit-earning basis, but that very sanguine expectations with regard to the future development of the business and payment of dividends are justified.

The contracts carried out by the corporation during the year include important work in almost every department of the electrical industry. The lighting of the Melbourne Centennial Exhibition, which proved eminently successful, and comprised the largest installation of the kind yet erected, was carried out almost entirely by means of the corporation's apparatus, supplied at very short notice to the Australasian Electric Light, Power and Storage Company. The contract secured for the arc lighting of the main building and grounds of the Glasgow Exhibition of 1888, was carried out to the thorough satisfaction of the executive committee, as will be seen from the following letter received from Sir W. Thomson :—" As chairman of the lighting committee of this exhibition, I have much pleasure in intimating to you my entire satisfaction with the manner in which your contract was carried out. During the entire period the 520 arc lamps installed by you have worked with the greatest regularity and steadiness." The illuminated fountain installation effected by the corporation at the Barcelona Exhibition, formed one of the most attractive features of the exhibition, and was universally described as far surpassing all previous similar undertakings. This contract met with the entire approval of the exhibition authorities, who have given the corporation their highest award of a gold medal.

The corporation have also been awarded a diploma in respect of their contract for lighting part of the Brussels Exhibition.

Amongst the installations on ships completed by the corporation during the year, may be particularly mentioned those on board the Castle mail steamers *Rosslyn Castle*, *Hawarden Castle*, and *Norham Castle*. Numerous installations have been carried out in private residences, factories, shops, offices, theatres, and other premises throughout the United Kingdom and abroad, and particular reference may be made to the completion of an important incandescence installation of 1,000 lights at Blenheim Palace, for His Grace the Duke of Marlborough, and also to the lighting of Prof. Piazzi Smythe's residence at Ripon.

The negotiations with the Honourable Commissioners of Sewers for lighting the City of London, have been continued; and it is confidently expected that at an early date specifications will be issued and tenders invited for lighting various sections of the City, for which the corporation will be in a position to submit a proposal with good prospect of success.

The advance in the different technical branches has been of a very marked character, and highly important results have been achieved, notably the perfection of the alternating current system of distribution, which enables electric current to be supplied economically over large areas without any risk of danger to the public. The corporation have designed a complete alternating current system which is now perfect in every detail, and has been in successful operation during the past year. This apparatus has met with great favour since its introduction, and is now being manufactured on a large scale.

The Victoria dynamo machine for running incandescence and arc lamps in parallel has been improved in design and mechanical construction, and is generally recognised as one of the most efficient machines for the purpose in the market. This dynamo has been found to lend itself admirably for use in connection with direct driving engines at slow speeds for installation on shipboard, and has been manufactured in large numbers for this application. The special engines supplied by the corporation from the designs of their superintending engineer, Mr. Raworth, meet with a ready sale, and constitute an important feature of the business.

The corporation's trade in incandescence lamps has been considerably extended, and their Victoria lamps have secured a wide reputation for durability and economy. When the Cheesbrough patent was upheld by Mr. Justice Kay, in the recent action of Edison and Swan *versus* Holland and others, the corporation at once devoted attention to the production of a lamp in which the Cheesbrough process of flashing could be dispensed with, and their efforts were so successful, that the present form of Victoria lamp ranks as one of the most efficient in the market.

The directors are glad to be able to state that the action referred to in the last annual report, which the corporation instituted in 1887 against the Orient Steamship Company, who were using dynamo machines made by Messrs. King, Brown & Co., of Edinburgh, in infringement of the Brush patent for compound winding, was decided wholly in favour of the corporation by Mr Justice Chitty, in December last, and the corporation were granted a certificate of validity of the patent, costs, and enquiry as to damages. Meanwhile, Messrs. King, Brown & Co. have brought an action in Scotland for the revocation of the patent, and this case is now before the Court.

With the above exception every dynamo manufacturer of importance in the country, has recognised the corporation's claim, and the royalties now received constitute an important source of revenue. In this matter the policy of the directors has been, while not harassing the trade or interfering with the growth of the industry, to protect the interests of the shareholders by charging a small royalty for the use by others of the corporation's patent. The directors, however, have no alternative but to resort to legal procedure, when the usual commercial methods of protecting the corporation's rights, and of enforcing their just claims, fail.

The action of the Edison-Swan Company against the corporation for alleged infringement of the Edison patent in the manufacture of Victoria incandescence lamps, is now under appeal to the House of Lords, the Court of Appeal, which had previously decided in favour of the Edison patent, in the case of "Edison and Swan Company *v.* Woodhouse and Rawson," having recently reversed the decision which Mr. Justice Kay gave after a most exhaustive hearing extending over twenty-two days. In view of the fact that the House of Lords will not be bound by the decision of the Court of Appeal in the Woodhouse and Rawson case, and that the issue to be raised will in many respects be a new one, the directors are advised that there is every prospect of the decision of Mr. Justice Kay in favour of the corporation being sustained.

The directors deeply regret the existence of this litigation, which is not only costly, but is a very great disturbance to the proper conduct and development of the ordinary business. Litigation is, however, not always avoidable, and that relative to incandescence lamp patents has been rendered necessary by the action of the Edison-Swan United Electric Light Company. That company and the corporation both hold patents for the manufacture of incandescence lamps, and it has always been the earnest desire and endeavour of your directors to respect the interests of the two companies and of the industry generally, by effecting a settlement equitable and honourable to all parties. In this effort, however, they have not as yet been successful, and have had no recourse but in the interests of the shareholders to defend to the utmost the action instituted by the Edison-Swan Company. The corporation have much to gain in the future by freedom from interference in their business as manufacturers of incandescence lamps, under the various patents they hold, but, unlike the Edison and Swan Company, they do not rely for their revenue mainly upon the manufacture of these lamps, inasmuch as the corporation's trade in these articles at present amounts to scarcely 10 per cent. of the total volume of their business.

The capital account shows an increase of £4,640, which arises out of the issue, under the resolution passed at the general meeting in February, 1887, of 1,160 new shares.

The increase in the patents, development, and goodwill account of £1,749 1s. 10d. is due to development of new inventions, and to the usual annual payments for maintenance of existing patents.

The profit and loss account includes a satisfactory profit derived from the Austro-Hungarian branches. This new department of the business has, during the past year, developed in every way satisfactorily, and bids fair to prove an important source of income in the future. The central lighting stations worked by the corporation are now also yielding good profits.

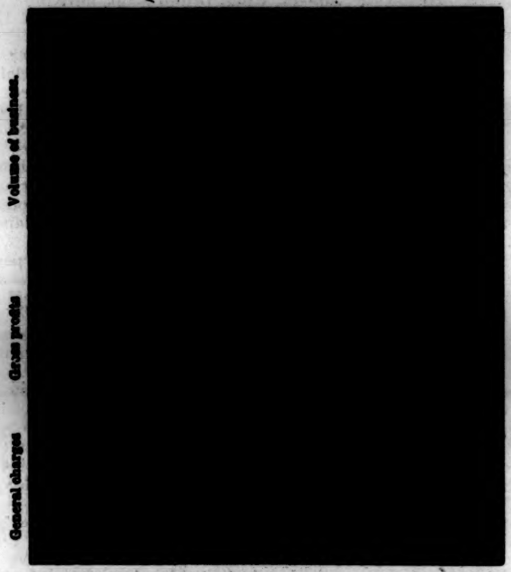
The directors consider the present a fitting opportunity for taking a general survey of the advance made during the five years which have elapsed since the reduction of capital in 1884, and with this view they submit a diagram showing the fluctuations during that period in the volume of the business, the general charges or expenses of management, and the gross profits. To facilitate comparisons between one year and another, the actual figures are shown on the diagram in percentages, the figures for the year 1883 being taken as represented by 100. It will be seen that the volume of business in 1888 is to that of 1883 as 307 is to 100, showing an advance in the five years of upwards of 200 per cent., and while the gross profits have increased in the ratio of 100 to 342·9, or over 242 per cent., the standing charges have *fallen* in a ratio of from 100 to 65.

The above figures do not take cognisance of the business effected through the Continental branches. If this be added, as shown in the diagram by means of dotted lines, it will be seen that the advance of the corporation's business is even more satisfactory, notwithstanding that the standing charges are relatively higher on the Continent than in England, which is due to the fact that the business carried on there by the corporation is still young; and it is probable that a much larger amount of trade could be effected without any material increase in the expenses of management.

The directors think it will be recognised by the shareholders not only that the affairs of the corporation have, during these five years, been conducted with energy and economy, but that, having regard to the hitherto undeveloped condition of the industry, and consequent difficulty and expense of working up a new business, the results must be considered as highly satisfactory and encouraging.

With regard to the prospects for the current year, the directors have every confidence in a still further improvement, the orders during the first two months of this year being more than double the orders received during the corresponding period of any previous year.

** Diagram shewing the fluctuations in volume of business, gross profits and general charges during the five years 1883—1888.*



Explanation:—The thick lines represent the figures of the respective categories without including the Continental Branches; the dotted lines represent the figures including the Continental Branches. The figures for the year 1883 are represented by 100 and the figures for the subsequent years are shown in relation to this standard.

The directors who retire this year by rotation are Lord Thurlow and Colonel Steuart, who being eligible, offer themselves for re-election. Messrs. Cooper Brothers and Company, the auditors, also retire and offer themselves for re-election.

Brighton and Hove Electric Light Company, Limited.

AT the meeting last week of this company, in the absence of the chairman (Mr. Robert Hammond), Mr. Philip Arderne Latham, one of the directors, took the chair. He said he had much pleasure in presiding and in laying before the shareholders such a satisfactory report and balance-sheet, showing that after debiting the revenue account, with the necessary outlays for keeping the plant in thorough repair, the directors were able to write off 5 per cent. for depreciation of plant and pay a dividend of 5 per cent., which dividend would have been much larger if the directors had not decided during the past year to run the machinery day and night in deference to a very generally expressed wish on the part of the customers. The new plant has given very great satisfaction to the consumers, who were able in private houses to turn on the light at any hour of the night or early morning and thereby found it a great convenience. It, however, kept the works in operation during the whole of the twenty-four hours, and entailed a great increase in wages and other charges, and he considered that it was a matter of great congratulation that in spite of these extra charges the 5 per cent. dividend which was declared twelve months ago had been maintained for another year. During the past year the Board of Trade's electrical adviser had visited Brighton and inspected the installation, and in consequence the company had received from the Board of Trade a request that the company should without delay apply for Parliamentary powers. In accordance with this important intimation from a Government Department, the company had applied for Parliamentary powers, but he was sorry to say up to the present time this application for Parliamentary powers had not received favour from either the Brighton Corporation or the Hove Commission. He considered this a great pity, because the company would prefer to work harmoniously with the Brighton Corporation and the Hove Commission, instead of obtaining powers over their heads; for he would point out that the Electric Lighting Act gave to the Board of Trade power of granting a Provisional Order in spite of the opposition of a Corporation, in cases where they considered that the opposition was of an immaterial character, and in view of the fact that the Board of Trade could pay any attention to the slight objections which had been raised by the Brighton Corporation and Hove Commission. He was, however, in hopes that a *modus operandi* could be arranged by which the company could work in friendly accord with both the local bodies. Their one desire in applying for statutory powers was to abolish the overhead wire system and run mains underground, but the shareholders would understand that it was impossible to do so without obtaining Parliamentary powers. As soon as the mains were run underground the company would be enabled to greatly improve its service by putting in larger mains and getting a better regulation of the light. The shareholders of the company had recently met and sanctioned the raising of the nominal capital of the company from £25,000 to £100,000, and the change of the name from the Brighton Electric Light Company, Limited, to the Brighton and Hove Electric Light Company, Limited. When the Parliamentary powers had been obtained, the shareholders would be called together and consulted with regard to further plant for the extension of the company's operations. He might mention, too, that the directors had in contemplation the immediate erection of a central station on the confines of Hove with a plant sufficient to supply 12,000 incandescent lamps somewhat upon the scale of the station which had recently been erected by a kindred company in London. He had much pleasure in moving that the report of the directors and the accounts for the year ending December 30th, 1888, be received.

This resolution was seconded by Mr. Arthur Wright, and carried unanimously.

It was then moved and carried that the retiring directors, Mr. Robert Hammond, the chairman of the company, and Mr. Arthur Wright, managing director, should be re-elected.

The Chairman then moved that the auditors of the company for the ensuing year should be Messrs. Ball, Baker, Rowe and Co.

This was seconded by Mr. Jerrard, and carried unanimously.

It was proposed by the Rev. H. Revell Reynolds, seconded by Mr. Joseph Cash, and carried unanimously, that the directors' fees for the coming year should be fixed at £200, this sum to be divided among the directors as they think fit.

A vote of thanks to the chairman terminated the proceedings.

The Direct Spanish Telegraph Company, Limited.—The board has, upon the audited accounts for the half year ended 31st December last being submitted to them, decided to recommend the payment of dividend at the rate of 10 per cent. per annum on the preference shares, and a dividend at the rate of 4 per cent. per annum on the ordinary shares, free of income tax, making, with the previous distribution, a dividend at the rate of 4½ per cent. for the year 1888 on the ordinary shares, against 4 per cent. in 1887, and to carry forward £723 5s. 3d. to next account.

TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company, Limited. The number of messages passing over the lines of this company during the month of February was 4,151, estimated to produce £3,300, against 4,535 messages, producing £3,686 in the corresponding month of last year. The traffic receipts for the month of November, estimated at £3,100, realised £3,107.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending March 1st, 1889, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £4,467.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 28th February are £2,696, as compared with £3,201 in the corresponding period of 1888. The November receipts, estimated at £5,303, realised £5,288.

The Eastern Extension, Australasia and China Telegraph Company, Limited. The receipts for the month of February, 1889, amounted to £37,584, against £36,785 in the corresponding month of 1888.

The Eastern Telegraph Company, Limited. The receipts for the month of February, 1889, amounted to £54,611, against £51,261 for the corresponding month of last year, or an increase of £3,350.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of February were £2,008, against £1,858 in the corresponding period of last year.

The Great Northern Telegraph Company, Limited. The receipts in February, 1889, £19,800; January 1st to February 28th, 1889, £42,000; corresponding months, 1888, £41,800; and of 1887, £39,600.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ended March 1st amounted to £5,337.

The West Coast of America Telegraph Company, Limited. The gross earnings for the month ending February 28th are £5,900.

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

"Some electric lighting central stations in Europe, and their lessons." Read 28th February, 1889, by Prof. GEORGE FORBES, F.R.SS. (L. & E.), member.

PART I.

Before commencing the subject of this paper, I think it may be well if I give you some idea of the reasons why I have brought the subject to your notice. You are aware that great strides are about to be made at the present time in electric lighting in this country, specially by means of the Gaulard and Gibbs system with the converters put in parallel. To complete the practical details of such a system involves a large amount of experiment, and whether low-pressure or high-pressure work is in question, I have frequently maintained that a great deal of experience has still to be bought and time to be wasted. It has appeared to me that we can only hope to ensure the best success of electric lighting schemes now in hand if we bury our pride a little, and try to obtain the experience of foreign countries without paying for it or wasting time over it, as they have done. I do say that we are wanting in the experience, and I see all over the country work being done where the rules of experience have often been set at defiance; and my object in introducing this subject is chiefly for the second part of the title of the paper, namely, a discussion of the lessons which can de derived from a study of the work which has been done abroad. The object of this paper, then, is to raise a discussion on the details of central station lighting and electrical distribution, and to enter a protest against defective systems, which, without some such discussion, I feel sure will be as plentiful in the near future with us as they have been up to the present time.

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* The diagram is an exact reproduction of that issued by the corporation, but the gross profits curve appears to have been very carelessly drawn, inasmuch as the profits for 1888 are shown almost on a level with those for 1885.—EDS. ELEC. REV.

I believe that my object can be best attained by proceeding, first, to describe the principal central stations in Europe which I have lately visited, pointing out specially the features in which they differ from the practice in this country so far as hitherto developed; and then to discuss the details, with a view of deriving the most profitable lessons from them as to what to adopt and what to avoid. I will deal only with what I believe to be the three most important central stations in Europe, namely, Berlin, Rome, and Milan. I have already partially dealt with America elsewhere.*

Berlin is supplied on the low-tension direct-current system, as originally developed by Edison, except the arc lights, which are on a high-pressure direct-current circuit.

Rome is supplied altogether, both for arcs and incandescent, on the Ganlard and Gibbs system, with converters arranged in parallel.

Milan is worked by Thomson-Houston apparatus for arcs, and by both low-pressure currents and high-pressure alternating currents for incandescent lamps.

At all the European stations which I have visited I received the same cordial welcome which I have always had in America, and the same desire that I should thoroughly inspect every part of the works. The stations have literally been placed at my disposal to watch the action of the machinery and to see what attention is required for its management. I have been allowed to interchange dynamos at will, and generally to learn all that was possible. I must especially record my thanks to Signor Pouchain, Prof. Mengarini, Signor Trenza, Prof. Colombo, Mr. Lieb, Herr Rathenau, and Herr Datterer for the willingness with which they imparted to me so much information in the details of their working, and to Mr. Zipernowski and Messrs. Ganz & Co. for much valuable information.

BERLIN.

The Berlin mains are at present, I believe, supplying a larger number of lights than any other connected system of mains in Europe. They supply 36,000 lamps of 16 candle-power, and 144 arc lamps of 15 ampères. The conductors are all laid underground. There are three central stations at work, and two more of improved type are in process of construction. The existing stations are:—1. Markgrafen Strasse. 2. Meuer Strasse. 3. Friedrich Strasse. Those about to be added are:—4. Spandauer Strasse. 5. Schiffbauer Damm.

The first is the most important; the third is quite unimportant. Here the boilers are by Steinmiller, and anthracite coal is used to prevent nuisance from smoke. The foundations are of concrete in iron boxes, built up with brickwork and cement. There are six engines of 160 horse-power each, each driving old-fashioned Edison six-legged dynamos. There are also four engines of 400 horse-power each, each driving a new type of dynamo direct at 80 revolutions per minute. These are compound tandem Corliss condensing engines by Van den Kirchove, of Ghent, who is one of the few foreign makers of engines who can compete with this country. The attached dynamos are by Siemens and Halske. The Electric Company of Berlin are also making a machine somewhat similar. The height of this dynamo and of the engine combined is 23 feet. These continuous current dynamos have never been built in this country, and are worthy of some notice. They may be described as multipolar Gramme machines, the poles being radial, and the ring armature external to the poles.

There are 10 poles on each machine. The armature is 3 metres in diameter; the commutator is 1½ metres in diameter. There are 10 brushholders. Each pair of poles, and the corresponding part of the armature, with the corresponding pair of brushholders, constitute a section which is virtually one machine. All these sections are joined in parallel. The field magnets are inside the armature. Two handles are provided, one of which adjusts all the brushes at the same time; the other puts them on all together. Each brushholder carries four brushes. A similar dynamo is being made by the Berliner Elektricitäts-Werke, in which the radial poles are external to the armature. I believe that this type of multipolar machine is a good design where the object is to get a large output with a slow speed. I hold working drawings in my hand of a similar design prepared by myself in 1881, but it was never executed. The number of bars of the commutator and the number of parts generally make it expensive to construct.

At this station the boilers are fed automatically by means of a hydraulic accumulator. The water for condensing is drawn from fifteen artesian wells which have been sunk for this purpose. Steam is used at a pressure of 115 lbs., and it is claimed that 15·5 lbs. of steam only are required per electrical horse-power. This is probably the most economical production of electricity for central station work in the world, and the engines and dynamos, though expensive, must certainly have a very low depreciation. The maximum work which this station can do is to generate a current for 26,000 lamps of 16 candle-power. It is found that the maximum number of lamps in use at any one time is about 66 per cent. of the total number of lamps.

The thing which strikes one most in this station is the enormous mass of copper. The conductors inside this station consist of eight strips of copper, 6 inches wide and ⅓rd of an inch thick. These are laid into the room for cable terminals. These strips, before entering this room, are interrupted by a gap, and a junction is made by punching seven similar strips, about 18 inches long, between the strips and the interrupted ends, the seven strips being placed between. Thus, in case of any serious accident, the whole of the mains can, by one turn of a screw, be disconnected from the dynamos, the interlapping pieces all dropping out. The only exception is in the case of theatres, where, to prevent panic, a separate connection is made with the dynamos. In the cable terminal room the positive and negative mains run horizontally, and vertical rods come down to the different cables. There are 84 of these cables, forming 42 pairs of feeders supplying the network of mains with current on the two-wire system. These cables are generally of large size, being frequently 3 inches in diameter complete. They consist of stranded cables covered with jute prepared with bituminous compound, enclosed in lead, then covered with tape and preservative compound, and finally armour-plated with two crossed spirals of iron ribbon. The system of feeders and mains is one of the features to which I wish to direct the special attention of English engineers, since the principle has been adopted of trying to produce as small a variation of pressure in the mains as possible. This is accomplished by having a large number of converters. The cost of the underground cables has hitherto amounted to about £90,000, half of this being spent in mains and half in feeders. The greatest variation of pressure allowed in the mains is 1½ per cent. The loss of pressure in the feeders during periods of maximum supply is 15 volts.

The next point which I wish to draw special attention to in connection with the Berlin central station work is the type of cable which I have now described. This cable succeeded very well for three years, but lately they have been giving way very generally. The lead gets eaten into and water percolates to the copper, which is then destroyed. At first it was supposed that the deterioration came from the cable being pierced by the borers used by the gas people, but it was found that the same fault is produced even in iron pipes which have remained uninjured. It is supposed that the deterioration of the lead may be due in some way to its forming a galvanic element with the iron sheathing. Whatever the cause may be, the fact seems to be established that such cable will not stand underground electric light work for more than about three years. These cables generally run under the footways without any casing, and are connected by circular junction boxes to the houses, powerful clamps and no soldering being used for the contacts. All the dynamos feed direct on to the mains in parallel. One feeder alone, serving the mains close to the station, has a resistance in circuit in the station to equalise its loss of pressure to the others.

A few detached facts strike me as being worth noting.

Each 16 candle-power lamp uses 50 to 55 watts; the charges for electric supply are 6s. per lamp per annum, and 9·6d. per Board of Trade unit; the Aron meter is universally employed; the price of gas in Berlin is 4s. 10d. per 1,000 cubic feet; the distances from central stations to lamps extend to 1,000 or 1,200 yards; 100 kilometres of cable have been laid on the two-wire system; each of the large machines can supply 3,000 to 3,500 lamps of 16 candle-power, and the largest cable is 1½ square inches of copper in section.

I spent a long time in this station, and had machines taken off and put on—an operation which occupied two or three minutes. I took careful note of the amount of skilled attention which was required, and saw that it was considerable. A man of high training, accustomed to the use of scientific instruments, is always in attendance, and looking after the ampères and volts from the different machines and pilot wires, and recording the measurements. It struck me that the working of this station was thoroughly German—certainly not American—but it was most methodical, and very effective. One of the most interesting parts of this central station is the switchboard, with the special means for introducing a fresh dynamo in parallel, or cutting it out. This also is a point to which sufficient attention has not generally been given in England. In all foreign stations that I have ever seen, when a current of over 100 ampères is switched in or out, it is found necessary to make use of an auxiliary load in the form of resistances, a bank of lamps being generally employed as being the cheapest resistance available. When a new dynamo is going to be introduced in parallel, it is first worked on an artificial load, and the exciting current regulated until the volts and ampères agree with those of the other dynamos with which it is to be put in parallel. As soon as this equilibrium is attained, the mains are switched into connection with the new dynamo and its load. After that the load is taken off. This prevents the possibility of the dynamo thus introduced being caused to run as a motor in the wrong direction by the current from the other dynamos, and prevents too violent a sparking at its brushes. The switchboard at this central station for the four large dynamos, with the accompanying artificial load or resistance, and with its ammeters and voltmeters, is very perfect. Facing the operator, the switchboard is in four sections for the four dynamos. Each dynamo has three massive double-pole switches—one for the dynamo, one for the artificial resistance, and one for the mains. Plugs can be inserted for varying the resistance on the artificial load. The ammeter is placed above these switches for each machine, and a voltmeter can be attached to any one of them, as required.

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* British Association, 1888.

The second station is in the Mauer Strasse. This station helps to feed the mains for incandescent lamps. It also supplies arc lights arranged in twelve circuits all arranged in parallel, each circuit having twelve arc lamps of 14 to 15 ampères. Here three Siemens machines of the old type are driven by a countershaft. Three Siemens and Halske new type multipolar machines are also at work, and four Edison machines and six multipolar machines of low tension. 11,000 lamps of 16 candle-power can be supplied besides the arcs.

Sixty-eight feeders, or thirty-four pairs, start from this station.

The Friedrich Strasse station is small, and was the commencement of the present system. Here four six-legged old-type Edison machines, each of 75 horse-power, are driven by Armington-Sims engines, and feed the general system of mains. Fifty-two men are employed on the three stations in eight-hour shifts. The Berliner Elektricitäts-Werke paid last year a dividend of 5 per cent.; the Algemeine Elektricitäts Gesellschaft, which does the central station work, paid last year 7½ per cent. In special districts 800 or 900 lamp-hours per annum are used; in residences only 400 or 500 lamp-hours per annum. Load diagrams showing the current used at different hours of the day in each month, and the proportionate cost from different causes, fixed and variable, have already been published.

MILAN.

The central station in Milan is not of the highest importance, so far as we can learn anything from it, except on one important point. The principal streets throughout the whole town are lighted by Thomson-Houston arc lights to the number of 350. This lighting gives us some idea of the manner in which this metropolis will soon be lighted; and anyone who sees it and realises that this clear, white, brilliant illumination may be made to brighten our wider thoroughfares and to penetrate our darkest slums, will realise that when London is as far advanced in adapting these possibilities of civilisation as Milan is, we shall lead healthier, happier, and purer lives, and our streets will be less notorious throughout the world as the hotbeds of immorality and midnight assassination.

The station has 14,000 incandescent lamps of 16 candle-power. The maximum load is 60 per cent. of the number of lights installed.

At this station it has been found quite practicable to use Siemens ratchet arc lamps of only 4½ ampères, the upper carbon being 12 mm. diameter and 200 mm. long, the lower one 7 mm. diameter and 200 mm. long, lasting 7½ to 8 hours. For longer duration larger carbons are used up to 15 hours. This is the first station where I have seen an arc lamp with so low a current in use. A certain resistance is put in series with the lamp, and two lamps are put in series on the mains feeding the Edison lamps.

The La Scala Theatre has 2,800 glow lamps of 16 candles and 30 arcs on the same mains.

Edison meters are used, and have given great satisfaction. The price is fixed on a sliding scale varying from 7d. to 1s. per Board of Trade unit. Gas now costs about 6s. 9d. the 1,000 feet. Before the electric light was introduced it was 10s. 6d. the 1,000 feet.

Two of the theatres are supplied by two Zipernowski machines, each of 40 ampères and 2,000 volts. For these circuits Siemens's concentric cables, of which a specimen is exhibited here, are used, the section being 28 square millimetres. Four Thomson-Houston machines are supplying 35 arc lights each, and four more are supplying 30. Half of these are single and half double carbon lamps, the single ones being put out at midnight.

I should mention that the coal used costs 27s. 6d. per ton, but labour is cheap.

Ten Babcock and Wilcox boilers supply the steam. The engines are all non-condensing. The low-pressure system is a two-wire system. Twenty-eight cables, or 14 pair of feeders, supply current to the mains. No pilot wires are used, but a man reads the ampère-meter and sets the volts by a table. There are 10 Edison machines of what is known as the Jumbo type feeding mains on the two-wire system. They were originally supplied each with a separate regulator for adjusting the exciting current, but connecting gear has now been introduced which works them all simultaneously. A fan is provided for driving air through holes in the poles of the field magnets. The whole of the low-tension system is antiquated, and we have little to learn from it except what to avoid. I found the arrangements for switching dynamos in and out worked very well. An artificial load of lamps is used at one part of the room, a main going thence past each dynamo. Thus two men are required to put in a new dynamo. It is first put on to the lamps, the machine being excited to the same extent as the other ones. The load of lamps is changed until the volts are the same as on the working circuit. A signal is then given, and the dynamo with its load is switched on to the working mains. The load of lamps is then removed. This is simpler than at Berlin, owing to the fact that the exciting current is known beforehand, but less simple owing to the dynamo switches being distant from the lamps and voltmeters. Ten machines work thus in parallel without trouble, which is a very good performance.

At Milan the average cost for wiring houses is only £1 per lamp. Wages are one-fifth of the total working expenses, coal is one-half, lamp renewals (undertaken by the company) is 7 per cent. The capital is £120,000, of which £24,000 has been spent in mains. The company has paid a dividend for several years. It is steadily increasing, and was 4 per cent. last year. There is a large reserve fund.

(*To be continued.*)

SECONDARY GENERATOR PATENTS.

IN RE GAULARD AND GIBBS'S PATENT.

THE previous proceedings before this Court in this case will be within the recollection of our readers. In the first place, Mr. Sebastian Ziani de Ferranti, the patentee of an invention (No. 15,141, 1885) for improvements in secondary generators, and the sale of whose apparatus was interfered with by the owners of the Gaulard and Gibbs patent (No. 4,362, 1882), also for secondary generators, instituted a suit for the revocation of the latter patent upon the grounds set forth in the judgment of the Court of Appeal. This suit came before Mr. Justice Kekewich, and on July 9th, 1888, he made an order for the revocation of the patent. Messrs. Gaulard and Gibbs appealed, and the arguments in the appeal were heard before Lords Justices Cotton, Lindley, and Lopes in January last. The Court delivered judgment on Monday.

Mr. Aston, Q.C., and Mr. J. C. Graham appeared in support of the appeal; Sir Horace Davey, Q.C., Mr. Moulton, Q.C., and Mr. L. E. Pyke for the respondent.

LORD JUSTICE LINDLEY delivered the judgment of the Court. He said: This is an appeal from an order made by Mr. Justice Kekewich, in which he declared in substance that the patent granted to Messrs. Gaulard and Gibbs was invalid. That order was admitted under section 26 of the present Patent Act, which is substituted for the old action of *scire facias*. The objections taken to the present patent are as follows—viz. (1) that having regard to the previous state of knowledge, the patentee's invention was not one for which a patent could be obtained; (2) that the complete specification is not for the same invention as that described in the provisional specification; (3) that the nature of the invention is not particularly described and ascertained by the complete specification; (4) that the complete specification has been so enlarged by amendment as to destroy the patent; (5) that the patented invention is not new. This last objection is so connected with the first as really to merge into it. In order to deal with these objections the first thing to be done is to discover what the invention really is according to the patentee's own description of it. For that purpose, the complete specification in its original shape ought to be studied in the first instance rather than the provisional specification, for the former document particularly describes and ascertains the invention, while the latter only states its general nature. If the provisional specification is studied in the first instance a general, but loose and inaccurate, idea of the real invention is likely to be obtained, and an incorrect conception may be thus formed, and if formed will probably lead to error. Turning then to the complete specification as it stood before it was amended, let us see what the invention really is. The patentees claim to have discovered a new system of distributing electricity for the production of light and power. The system consists of a combination of the following particulars—viz. (1) an alternating current of high tension produced by an electro-dynamo machine; (2) the passage of such current through a number of electrical generators of special construction; (3) the formation of such passage of induced currents, the quality and value of which depend only on the construction of the secondary coils of the electrical generators; (4) the utilisation of these induced currents for the production of light or motive power. The specification and drawings show that a main wire is to be used for the passage of the current produced by the electric dynamo machine, and that this main wire may be miles in length, and that the electrical generators are to be attached to this main wire where wanted. In the first instance it was said that there might be an unlimited number of these generators; this expression has been amended, and the word "unlimited" has been struck out. This amendment does not, in our opinion, affect the validity of the patent. There may be as many electrical generators as can in practice be wanted, and that is all that anyone would understand by the use of the word "unlimited" in connection with the rest of the specification. Having stated in general terms what the patentee's system or invention really is, it is necessary to ascertain what according to the original specification is the most essential element in it. This is the specially constructed electrical generators. It is impossible to read the complete specification as originally drawn without seeing that everything turned on these. The quality and value of the induced currents is said to depend only on the construction of the secondary coils, and they are specially claimed by the patentees in their third claim. It is also impossible to read the provisional specification without coming to the same conclusion. It is therefore necessary carefully to study these forms of generators. The electrical generators described in the specification and shown in the drawings are induction coils. The patentees describe two forms of them. They do not say no others will do; nor do they point out what in particular is the essential feature of either of them; but the patentees describe two forms which have certain common features, and there is no reason to suppose that the forms described were not the best known to the patentees when they filed their specification. There is evidence that the forms described will produce the desired results, and there is no evidence to the contrary. Moreover, there is strong evidence that any competent workman could make induction coils which will produce the desired results by following the specification and drawings, and using such knowledge as he would himself possess. The patentees suppose a main wire 50 kilometres long and a secondary generator—*i.e.*, induction coil, at every 500 metres. The size of the main wire is not stated. The first example of induction coil consists of—(1) a central core of soft iron wire capable of being drawn out or pushed into the hollow tube made by the wire coiled round it, and referred to generally. The word in the specification is wire in the singular; but we understand that any competent workman or electrician would see that a bundle of wires and not one wire was meant, and we so read the specification; (2) a copper wire of about three millimetres in diameter, perfectly insulated in three rows of superposed coils round the core. This is the primary wire, and its length is not stated; (3) bobbins placed over the cylinder formed as above; (4) a cable wound round each of these bobbins, and composed of six copper wires of half a millimetre in diameter, each strand being insulated by means of paraffined cotton. This cable of six wires forms the secondary wire of the induction coil, and its length is not stated. The second example of induction coil consists of (1) a core like the above; (2) an insulated primary copper wire four millimetres in diameter, surrounded by six cables, each composed of 12 insulated copper wires of half a millimetre. These cables are the secondary wires, and they are to be arranged parallel to and completely surrounding the primary wire, so as to form with it one cable. The proper lengths of the wires are not stated. (3) The cable thus formed is rolled on a hollow cylinder of wood, say 50 centimetres long and six in diameter; (4) each layer of spirals is separated from the other by two cylindrical segments of iron two millimetres thick, and without contact to avoid heating; (5) the extremities of the six fine wire cables are united to a commutator, which allows of their being grouped either in tension or quantity.

It is apparent from these two descriptions that the patentees represent the cable formation of the secondary wires to be important; quite as important as anything else they described. This, however, is admitted not to be the case. Having thus arrived at the nature of the invention and the mode of carrying it out, as described in the specifications, let us turn to the evidence given at the trial. We have studied this with care and have come to the following conclusion:—(1.) Although some of the specifications in earlier patents come very near the patentees' invention, none of them quite come up to it. No one had previously hit on a combination of (1) an electric dynamo machine producing alternating currents of high tension; (2) a long main wire; (3) induction coils specially constructed, placed along it at intervals for producing light or motion where required. The alleged anticipations all fall short of this. (2.) The patentees' system is essentially the combination just mentioned. It was new, apart from the special construction of the induction coils; the system is indicated, as Sir William Thomson says, in the drawings to the provisional specification without the letterpress. (3.) Nothing really turns on the specially-constructed secondary generators on which the patentees unfortunately laid so much stress. They are not types of any class which has not all their special features. (4.) Any competent person, having once seized the idea of the combination shown in the drawings, would see at once how to carry it into effect, and would, without difficulty or further instruction, select an induction coil suitable for his purpose without adopting either of the specially constructed coils, and without being told by the specification the lengths of the wires to be used or the ratio which one of them must bear to the other in length, size, or weight. This is, in our opinion, the true result of the evidence. Any competent electrician would see that a long main wire must, for economical reasons, be as small as circumstances would allow; that the tension of the current sent along such a wire must be high, far too high to bring into a lamp with safety; that this tension must be reduced; that induction coils could be made to reduce it; that the lengths and thicknesses of the wires would depend on the object to be attained, and could be ascertained from the law of tension, a formula given in Clerk Maxwell's book. The evidence, in our opinion, proves all this; and the state of knowledge was such as to supply the absence of instruction in the specification respecting these details. The nature of the invention is particularly described and ascertained, and two modes of carrying it into effect are sufficiently described to enable any competent electrician who seizes the idea to give effect to it notwithstanding the want of detailed instruction. It is not necessary for us to decide whether the patentees could or could not have obtained a valid patent for their system apart from their specially constructed induction coils. Perhaps they might have done so. Unfortunately that was not their intention as originally described. They have so over-estimated the value of their specially constructed generators and have so drawn and altered their specifications as to have missed their mark. As already stated, their special form of generator was originally made an essential feature of their system. This was a grievous mistake. They have tried to correct it by amending their complete specification, but in doing so they have entirely changed their front and the nature of their claim. To understand the effect of this amendment it is necessary to see what the patentees have done and what they now claim by their amended specification to be the invention for which they have obtained their patent. The amended specification is vague and ambiguous on this very important point. If confined to a combination of dynamos giving alternate currents of high tension with a main wire and one of the two induction coils specially described, the patent will be of little or no use to the patentees; whereas, if construed more extensively so as to include a combination of such a dynamo with any induction coil having the properties of the two described, the patent will be of immense practical value, for the evidence shows that any coil which any one would be likely to make would have such properties. The second of these two constructions is, therefore, obviously that which will be most beneficial to the patentees. It is the construction which the patentees have laboured to maintain. The whole of their evidence was addressed to this. No serious attempt was made to show that there was any merit in the two specially described generators except their movable iron wire cores, which almost all induction coils had in 1882. We are satisfied that no other construction is worth contending for, and it is, in our opinion, the true construction of the specification as amended. The specially constructed generators are no longer claimed, either separately or as essential parts of the combination. They are seen to have no particular value, and are dropped accordingly. This construction of the amended specification renders the patent hopelessly bad in law; for, first, on this construction the invention is not the same as that described in the provisional specification, but an entirely different invention; and, secondly, on this construction the amendment of the complete specification has greatly extended the scope of the patent. As already shown, the essence of the invention, as described in the complete specification in its original shape, and as set forth in the provisional specification, lay in the use of a specially constructed generator (or combination), which the patentees believed to be superior to all others, and, in fact, to have magical powers; and if they throw this over they so far depart from their invention as described in these documents as to render the patent they have obtained for it worthless and incapable of being supported. The law upon this point is perfectly well settled, and it is useless to refer to authority for it. This view of the case renders it unnecessary to consider whether the patent could be supported if it were construed narrowly and confined to a combination for an alternating dynamo with induction coils constructed like one of the two described in the specification. This point was not much argued. The decision in favour of the patentees would be of little use to them, and the petitioners do not care which way it is decided, as they say they do not use that particular combination. This point, if it fairly arose, would, we think, be found full of difficulty, considering the evidence given at the trial. But, having regard to the terms of the specification and the real contest between the parties, wo do not think it calls for decision. In our opinion the patent is bad, and the appeal must be dismissed with costs.

COMPOUND-WINDING PATENTS.

KING, BROWN & CO. *v.* ANGLO-AMERICAN BRUSH ELECTRIC LIGHT CORPORATION.

(*Continued from page* 251.)

DESCRIBE the operation of Haddan's commutators which are described in the third division of his specification, and claimed in claims 2, 3, 4, 5 and 6?—The operations of the commutators described in the third division of the Haddan specification and claimed in claims 2, 3, 4, 5 and 6 is as follows:—First, it resolves the alternating currents that are generated in the armature into a continuous current in the field magnet coils and the external circuit; second, it cuts opposite bobbins of the armature out of circuit and operation when they are at and sufficiently near the neutral or current reversing point in the field, leaving them in circuit and active only while they are effective in developing current; third, the special construction described in division three, and pointed out in claims 2, 3, 4, 5 and 6 enables the segments of the commutators as they become too much worn to be readily and cheaply renewed without disturbing any permanent mechanical or electrical connections, and without disintegrating the machine or commutator in any way.

Point out how it comes to pass that only one insulating segment is required between two wearing segments?—The object of the insulating segment in my commutator is to cut out of circuit at the proper time the two armature bobbins with which it is associated. This is done, and by simply opening the circuit of these bobbins through the agency of the insulating commutator segment, and one segment is as effective for this purpose as more than one could be; and for the sake of simplicity I use but one insulating segment for each set of armature bobbins.

What are the advantages of making the commutator in the form shown in the drawing, both when the insulating segment is made of metal and when it is not?—Understanding that you refer to the special construction of commutator pointed out in division three, and claims 2, 3, 4, 5 and 6 of the Haddan specification, my answer is that the advantage of thus making the commutator has especial reference to simplicity, durability, and facility of repair. Unless the detachably-detached wearing segments of the commutator are provided, it is necessary whenever the segments are too much worn to more or less disintegrate the machine by destroying the permanent electrical and mechanical connnections between the segments and their respective conductors with the armature bobbins, which requires time, labour, and expense, and is attended with more or less danger of electrical derangement in the machine. By providing the detachably-attached segments the entire wearing parts of the commutator can be quickly, accurately, and cheaply renewed whenever necessary without any disintegration of the machine and without any disturbance of the permanent electrical and mechanical connections between the commutator and the balance of the apparatus.

What are the disadvantages of the forms of commutators in use at the date of Haddan's specification?—Understanding that this question refers to the feature of the commutator, I will say that the disadvantages of the forms of commutators in use at the date of Haddan's specification resided in the necessity of more or less disintegrating the dynamo whenever it became necessary to renew the commutator segments when too much worn. With these former commutators the permanent mechanical and electrical connections between the segments and the armature bobbins had to be completely destroyed and again renewed. This entailed an outlay of time, labour, expense, and risk, that is totally obviated by the provision of the detachably-attached wearing segments and the permanent non-wearing sub-segments.

Have you made and sold any commutators such as those claimed in claims 2, 3, 4, 5 and 6 of Haddan's specification?—Yes; thousands. I have adopted and used this construction of commutator to the exclusion of any other kind.

Have you read the specification of Alexander Melville Clark, No. 4,311, of 1875?—I have.

Point out the differences between the apparatus there described and that claimed in Haddan's specification, No. 2,003, of 1878?—Clark's dynamo is a closed coil armature machine, which necessitates the Gramme form of commutator as shown in Clark's patent, while the Haddan dynamo is of a fundamentally different type, now known as the open coil armature type of machine. In detail of construction there is no similarity whatever between the Clark and Haddan dynamo. The field magnets of this Clark dynamo are simple shunt wound.

Have you read the communication to the Royal Society on the 14th February, 1867 by Sir Charles Wheatstone, published in the proceedings of that Society for 1866–7, vol. 15, page 369?—I have.

Point out the differences between the apparatus there described and that claimed in Haddan's specification, No. 2,003, of 1878?—Wheatstone describes as the best arrangement of his experimental apparatus what is now known as a simple shunt wound machine. The cross wire of which he speaks and in the circuit of which he gets the most available electric current, clearly corresponds with the external or working circuit of the modern simple shunt wound dynamo, while his field magnet circuit forms the shunt. Wheatstone appears to have used his apparatus in some experiments as a series wound machine and in other experiments as a shunt wound machine. In no experiment detailed in Wheatstone's paper did he employ both systems simultaneously, or hint at the possibility of such combined employment in any form of machine. Even with our present knowledge of compound winding, the apparatus clearly described by Wheatstone in his paper, could not be made to embody the principle of compound winding because Wheatstone's field magnet was provided with only one coil of wire. I am not aware that Wheatstone ever went beyond the mere experiments detailed in his paper, or that his paper ever led him or others to the construction or description of any new form of dynamo. On the other hand, Haddan accurately and carefully describes and illustrates compound wound field magnets and the proper manner of connecting their circuits in compound relation to each other in both the long shunt form and short shunt form, now well known in the art. Haddan also points out the results sought and attained by his arrangement of compound wound field magnets, namely, the constant maintenance of the magnetism and consequent potential at the terminals of the machine, whether the external working circuit to be opened or closed, and the adaptation of the machine to do in a normal manner widely varying amounts of work in a plating bath or work of an analogous character.

Are you acquainted with the machine referred to by the pursuers in their condescendence as having been made and used by Siebe and Gorman at their works in London in 1876—77?—I have no personal knowledge of the machine.

If so, point out in what was that machine different from the one claimed in Haddan's specification, No. 2,003, of 1878?—I have not such a knowledge of the Siebe-Gorman machine as will enable me to answer this question.

Are you acquainted with the machine referred to by the pursuers in their condescendence as having been made and used by the Electric Engineering Company, Mill Street, Ancoats, during the last twenty years?—I am not.

Are you acquained with the commutator first used and known as Wilde's?—I am not aware of any commutator that is called and known as the Wilde commutator, and cannot therefore say that I am acquainted with it further than to say that I have in mind a construction ascribed to Mr. Wilde whereby some of the armature coils were employed for separately working an independent circuit to energise the field of the machine. But I cannot say that I remember the particular construction of his commutator.

To the best of your knowledge and belief was the commutator claimed in claims 2, 3, 4, 5 and 6 of Haddan's specification, No. 2,003 of 1878, a new and useful invention at the date of Haddan's patent?—Yes. I so believed it to be at the time, and never had any reason since then for thinking or believing otherwise.

Cross-examined for the pursuers:—

Was the shunt dynamo described in Sir Charles Wheatstone's communication to the Royal Society of London on 14th February, 1857?—I have given my understanding of what is described in Wheatstone's paper in my answer to defender's 54th interrogatory, wherein I think I have also answered your foregoing question.

Shown the specification of letters patent granted to Alexander Melville Clark, No. 4,311, dated 11th December, 1876, and particularly the passages at page 2, lines 26 to 34; page 4, line 34 to page 5. line 4; and page 5, line 33 to page 6, line 5; the first claim on page 6; and figure 3 of the drawing—do the said passages and claim, or any and which of them describe a shunt dynamo; and also said figure delineate a shunt dynamo? If you answer "No" as to any of the said passages, or claim or figure, explain in what respect those as to which you give a negative answer fail to do so?—Consulting the Clark patent and its particular parts to which the question refers me, I find, as I have already stated, that the field magnets of this machine are simple shunt wound and connected, and to this extent the Clark patent shows a shunt dynamo.

Was a shunt dynamo described and claimed in the specification No. 2,003 of 1878 in favour of Herbert Joan Haddan as part of the invention therein sought to be patented? In particular, was such a shunt dynamo described and claimed in the following passages, or any and which of them, viz.: page 10, lines 19 to 22 and lines 35 and 36; page 11, lines 27, 28 and 29; and also figure 5 of the drawings, and claim 8 on page 15 of the first edition of the said specification? If you answer "No" as to any of said passages, claim or figure, explain wherein those as to which you give a negative answer differ from a shunt dynamo?—As regards the first part of the question I answer affirmatively. The parts of the first edition of the Haddan patent to which the question particularly alludes refer, broadly speaking, to a shunt dynamo. Figure 5 of the drawings, sheet 4, is intended to show simple shunt winding. Claim 8 was, I believe, intended to cover simple shunt.

Are all of the said passages still retained in the said specification No. 2,003 of 1878, as finally amended and disclaimed, except said claim 37 (see amended disclaimer and memorandum of alteration of the defenders, the Brush Corporation, No. 2,003, ... of 1878, page 11, lines 49 to 53; page 12, lines 8 and 9 and lines 55 and 56; page 13, line 1; and page 16, lines 14 to 17.)—All of the matter indicated in the question existed in the original Haddan specification, and it is all retained in that specification as amended and disclaimed, excepting claim 8, which was disclaimed and cancelled.

Do you in said passages so retained represent a shunt dynamo as part of your invention?—Most assuredly not as a part of my invention intended to be covered and claimed by the present Haddan patent. Had I designed or intended the simple shunt form of dynamo to constitute an embodiment to be comprehended by the Haddan patent the said 8th claim would not have been cancelled as it was. I considered, and still consider, that the cancellation of claim 8 removed from the Haddan patent all pretext that the simple shunt form of dynamo is intended to be, or is, in fact, embodied within the scope of the invention designed to be covered by said patent as it now stands. Whatever references to a simple shunt dynamo that now appear in the Haddan specification remained simply as gratuitous suggestions or descriptions of that which the patent does not claim or cover, and which serve to more clearly and definitely indicate by contradistinction just what the patent in its present shape is intended to include and cover, viz., a compound wound dynamo, so far as division 4 of that patent is concerned.

Being referred to page 11, line 33, of said amended disclaimer and memorandum of alteration, do you, at page 12, line 8, describe one form of device embodying your invention?—I understand the question to refer to the following passages which I will quote: "I will now proceed to describe the construction of one or more forms of device embodying my invention," and "fig, 5 shows another modified form of my device in which the main helix is omitted and the magnet clothed only with the teaser." In view of the fact that the disclaiming and cancellation of claim 8 was intended to eliminate from the Haddan patent all pretext to including the simple shunt winding as the invention or part of the invention intended to be embraced and claimed by the patent as it now stands; and in view, also, of the fact that the claim 8 was disclaimed and cancelled because the simple shunt form of dynamo was intended to be expunged from the Haddan patent as anything intended to be embraced and claimed thereby, and, finally, in view of the fact that the quoted portion of the patent alluded to in the question refers especially and only to the simple shunt form of dynamo, I will answer in the negative and say that the part of the Haddan patent specified in the question does not describe one form of device embodying my invention as now shown and claimed in this patent.

Does fig. 5 show one of the forms of your device?—No, not if the term device is to mean the invention now intended to be described and claimed as mine in the Haddan patent. Fig. 5 illustrates that which I disclaimed by cancelling claim 8. It illustrates that which does not constitute one of the forms of my invention, as that invention was intended to be limited and confined by the amendment and disclaimer of the original Haddan patent.

Does the form of device referred to in the last-mentioned passage and figure relate to a shunt dynamo the same, or substantially the same, as that described in the passages referred to in the first two questions in the cross-examination. If you answer "No," explain how it differs therefrom?—Yes, in so far as it related broadly to a simple shunt dynamo without reference to details of construction or combination with other parts or elements of the invention.

State in detail to which of the several purposes set out in the alleged letters patent 2,003 of 1878, each of the claims therein set forth was at that time regarded as severally applicable?—In the Haddan patent before its amendment and disclaimer, claim 1, referred to such or substantially such a dynamo armature as was illustrated in figs. 1, 2 and 3, sheet 2 of the drawings, and described in division 2 of the patent, claim 2 referred to the same. Claims 3, 4, 5, 6 and 7 referred to and were applicable to such, or substantially such, a construction of commutator as is illustrated in figs. 1, 2, 3 and 4, sheet 3 of the drawings, and described in division 3 of the specification. Claim 8 referred broadly to a "shunt wound" dynamo as illustrated in fig. 5, sheet 4. Claim 9 referred definitely to the "compound-wound" or "series-shunt" dynamo excluding the "simple-shunt" form. Claims 10, 11, 12, 13, 14 and 15 referred to a construction of electric lamp or light regulation, such or substantially such, as illustrated in figs. from 1 to 6 inclusive, sheet 5 of the drawings, and described in division 5 of the specification, and claim 16 referred to carbons used for consumption in electric lamps, said carbons being coated or covered with copper or other equivalent protecting or other electro-conducting metal.

Was it known in 1878 that the system of compound-winding, or what is the subject of claim 7 in the letters patent 2,003 of 1878, as finally amended and disclaimed, was applicable or useful in connection with electric lighting? When did this first become known, so far as you are aware?—In 1878 the art of incandescence electric lighting was still in its formative stage, and had not reached the practical development which it soon after obtained. My invention of the "compound-wound" dynamo played no unimportant part in the practical solution of the problem of incandescence lighting. So far as concerned arc electric lighting I very well understood in 1878 the non-unsuitableness of the compound-wound dynamo for operating arc lamps. But upon the production of my compound-wound dynamo its applicablity to incandescence lighting was apparent, and was recognised soon after.

Did you tell Mr. Swinburne in May, 1882, in Cleveland, Ohio, that you did not think a constant potential machine could be made, but that if he would take the responsibilty of ordering the machines you would make them, or anything to that effect?—I do not remember of ever making such, or substantially such, statements to Mr. Swinburne, and do not believe I ever did. I may, however, have discouraged, and probably did discourage, the construction of the special machines he wanted, knowing that the commercial demand for them at that time had not become sufficiently large to warrant the time and expense that would be necessary to determine the relative proportions and details of constructions.

Did you at that time discourage the construction of these machines, and if so on what grounds?—I do not remember that I did discourage the manufacture of these machines. If I did so, it was certainly not from any doubt of my easy ability to make them, but only for the reasons I stated in my last answer.

In your opinion, as at 1882, would such construction have required considerable time in calculation, superintendence, and testing on your part without leading to the construction of such machines at that time for commercial purposes?—Basing my reply upon my actual experience in making the first commercial machine of this kind, I can readily answer, "No." My first commercial compound-wound shunt dynamo for plating purposes was successfully produced without any extraordinary amount of time, calculation, superintendence, or testing. By this I mean a greater amount than I anticipated in carrying out the mere mechanical details and other work necessary in making a new machine that had already been fully thought out and completed in my own mind. In making any machine which involves a departure from those already being manufactured, it is always necessary to make drawings and specifications, and generally patterns therefor, and like all machines it should be tested before considered complete. All this, of course, requires time and labour; that must always be anticipated, and this I did anticipate in the production of the first machine alluded to. But I cannot say that the time and labour required was extraordinary or beyond my expectations.

Did you ever say to Mr. Swinburne in May, 1882, that you had discouraged the construction of these machines, knowing that such construction would require considerable time in calculation, superintendence, and testing on your part, without leading to the construction of such machines, at that time, for commercial purposes, or words to that effect?—I have no remembrance of any such conversation, either in substance or effect, and do not believe that it ever occurred. In 1882 I had the invention of the compound-wound shunt dynamo, and its essential principles of construction and operation, as clearly and distinctly in my mind as I have to-day, and could not have had any reason for speaking in effect, as the question implies. I had completed the invention of the compound-wound dynamo several years previous, and had filed my application for my United States letters patent thereon March 11th, 1878, wherein I had fully illustrated and described the compound-wound dynamo. Upon this application my American patent, No. 217,677 of July 22nd, 1879, was granted. I was fully prepared in the early part of 1878 to construct a compound-wound shunt machine, and could have made one then without any extraordinary consumption of time in calculation, superintendence, or testing on my part, and with a certainty of making a commercially acceptable machine. As a matter of fact, before the early part of 1878 my licensees in America were making and selling my compound-wound dynamo for electro-plating purposes, and a number of them were then already in very successful commercial use.

Explain why you so discouraged the manufacture, and what calculations and tests you had in view, and why such machines were not at that time required or suitable for commercial purposes?—If I ever offered such discouragement, it was probably because the machines Mr. Swinburne then wanted were of a special construction not then in commercial demand, and that I was not anxious to take the time and do the labour that would then or to-day be required to map out and construct machines that were not in the line of our regular commercial shopwork. This objection, if it was at the time stated, might be made to me to-day, although I would be certain of my ability to satisfy the request.

Referred to page 11, line 23, of Haddan's specification as finally amended, does the first portion of that sentence refer to a pure shunt machine?—Using the terms "pure shunt" and "simple shunt" synonymously, and upon examining line 23, page 11, as you request, I find that both a simple shunt and compound shunt machine are referred to.

Would a workman require to have recourse to experiment to make a constant potential machine from Haddan's specification? If you answer "No," explain and give the reasons for your answer?—Not necessarily, because the instructions of the patent are sufficient. He might or might not. That is to say, he might hit constant or approximately constant potential in his first construction of field coils, or being experienced in the construction of series machines of the same type, he might be able to calculate or judge of the proper proportions, as I did myself. He could not fail by following the specification and drawing to make an approximately constant potential machine, and a machine much better adapted for the purposes requiring constant potential than a series machine. In order to arrive at the greatest perfection of the constant potential result, he would doubtless require some experimental work. If in any particular instance any experiment should be required it would be experiment of such kind as not infrequently might occur to-day with one who fully understood the invention. Such experimentation would not require the exercise of any invention, nor would it amount to invention in any manner or degree.

Referred to passage page 11, line 45, would the form of machine there described be useful or workable to any extent?—It would not, and for the very reasons stated in the part of the patent referred to. There is here pointed out a method of winding which, although it might be employed, would be ridiculous, and this was intended to warn against such a distortion of my invention.

Were simple shunt machines used for electro-plating prior to Haddan's patent of 1878?—Judging from the statement made in the specification of the Clark patent, No. 4,311, of 1875, I should say that a simple shunt machine had been attempted to be used, or at least suggested for electro-metallurgical purposes, which evidently refers to electro-plating.

Is the constant potentiality of electric machines now regarded as a most essential feature of such machines in connection with incandescent lighting?—Yes. Approximately constant potential, at least. It is my own practice in the construction of series shunt dynamos for incandescence lighting to obtain not constant potential at the terminals of the machines, but constant potentials at the lamps themselves. For this purpose I so arrange the series shunt winding that the potential at the terminals of the machines shall slightly increase with increasing external load.

For the purpose of electro-plating, can a simple shunt machine capable of doing a large quantity of work at one operation, also do a small quantity of work? If you answer "No," explain and justify your answer.—Yes. But the small quantity of work in this case is liable to be spoiled by being done too rapidly on account of the rise of potential of the machine due to the diminished current produced.

Is a shunt machine liable to have its current reversed by the electromotive force developed in the plating bath?—No.

Is a compound wound machine used for electro-plating liable to have its current reversed from any accident, such, for instance, as a complete stoppage of the dynamo, however short?—If the dynamo should stop and the current of the bath traverse the machine it probably would, if this current were of any material strength, result in reversing the polarity of the dynamo. By no chance or variation of load could a reversal of polarity occur with the machine in normal motion.

Had you or, so far as you know, anyone else, any knowledge of incandescent lighting at the date af Haddan's patent?—Strictly speaking, yes. Incandescence lighting, however, had not reached its practical or commercial development and introduction in 1878.

Haddan's specification says, page 11, line 22, "other useful applications of a permanent field machine will readily suggest themselves!" What other applications suggested themselves to you readily in 1878?—One other use I had in mind was telegraphy. Several machines at that time had been constructed or attempted by others for the purpose of telegraphy.

Is it of great importance that the polarity in machines used for electro-plating should under no circumstances be liable to change?—It is.

In electric lighting is it of any consequence whether the polarity of the machine changes?—In arc electric lighting it is important that the dynamo should not change its polarity. In incandescence electric lighting, however, the lamps would burn as well with the dynamo current flowing in one as the other direction. But for incandescence lighting there are other essential requirements that necessitate the employment of a dynamo whose construction is of such a character that under ordinary and normal conditions, its polarity is not at all liable to reversal for whatever purpose it might be used, whether for operating lamps or otherwise.

Is the compound-wound machine more liable to change polarity when used for electro-plating than the plain shunt machine?—No.

Is it the fact that in all compound-wound machines a part of the electric energy produced by the machine is diverted to maintain the magnetism of the field magnets?—It is a fact that in such machines a part of the electric energy is used (not diverted) to maintain the magnetism of the field magnets. This is also true of all forms of dynamo-electric machines. In compound-wound machines the whole of the electricity or electric current produced is used to energise the field magnets. This is also true of "series" machines, but not of "simple shunt" machines.

Is Varley's description of how he prefers to employ a part of the electricity to maintain the magnetism of the soft iron magnets, page 8, lines 38 to 49 of his specification, No. 4,905, of 1876, not a description of series shunt winding? If you answer "No," explain and give the reason for your answer?—I cannot so understand it. Varley here distinctly states, "part of the electricity developed by the machine is diverted to maintain the magnetism of the soft iron magnets, and the remaining portion is used to produced the electric light." In a compound-wound dynamo all of the electricity developed by the machine, and not part of it only energises the field magnets.

At the date of Varley's patent were there several known ways of diverting a portion of electric energy for one purpose, and at the same time using the remainder of the electric energy for another purpose?—Wheatstone and Clark appear to have disclosed the simple shunt idea. These are all I have in mind at present.

Is it possible to make a compound wound machine work so as to give an approximate constant potential while at the same time doing work in the shunt circuit external to the machine? If you answer "No," give the reason for your answer.—Not if the external working in the shunt circuit is variable in amount, or involves a variation of resistance in the external part of the shunt circuit or involves the opening of the shunt circuit at intervals, however brief such openings be.

Was it a well-known mechanical device in 1878 to attach detachable wearing pieces to any machine liable to wear, so that they could be easily replaced when worn?—The question is too general and indefinite to allow of an answer that I could consider properly a reliable, responsive answer.

Is the third claim in Haddan's specification as finally amended indicated in the provisional specification? If you answer "Yes," point out where, and explain and give the reasons for your answer. —I quote the following from the Haddan provisional specification: "The invention consists . . . . . also in constructing commutators cylindrically with an insulating hub or body to which are attached metallic subsegments placed in electrical connection with the general mechanism in which the commutator is employed, and metallic wearing segments detachably attached to said subsegments of suitable length, style, and dimensions to suit this object." The three foregoing quoted passages all plainly define the same thing, and mean the same thing. There is no possibility of confusion or mistake in this fact. Therefore I say that the third claim in the Haddan specification as finally amended, is clearly indicated in the provisional specification. The third claim referred to in the question reads as follows: "3. The combination of subsegments, B, wearing segments, S or T, and screens, K, substantially as and for the purposes shown in division 3." Referring to division 3 of the Haddan completed specification I find the following language: "B, represents separate metallic plates or subsegments, S, T. P is a hub cylinder of wood or any suitable non-conducting material which serves as a carrier, and as means of attachment to the entire commutator, and is made

State wherein the novelty of what is claimed in the third claim consists?—Prior to the Haddan specification, so far as I am aware, when the commutator segments became too much worn, the commutator had to be practically disintegrated. The permanent mechanical and electrical connections of the segments with the machine had to be ruptured and destroyed, and again renewed for the new segments that totally replaced the old. As compared with this former method the novelty of what is claimed in the third claim consists in totally obviating and dispensing with the necessity of ever repairing or even disturbing either the mechanical or electrical connections of the commutator segments proper with the general machine. When my detachable wearing segments need renewing, they can be quickly, conveniently, cheaply and safely removed from their respective subsegments and the entire commutator in a few minutes made new again without having in the least ruptured or destroyed any permanent mechanical or electrical connections.

State wherein the utility of what is claimed in the third claim consists?—The utility of what is claimed in the third claim as compared to what existed in the art prior to the Haddan patent, consisted in a very great and material reduction in the cost, labour, time, risk, skill and all the trouble and objections generally connected with and attendant upon the repair or renewal of worn out commutators.

Wherein does the subject matter of the third claim differ from the subject matter of the second claim?—The third claim in part is definite and restricted in its character, limiting the construction to the use of screws for uniting the subsegments and wearing segments. On the other hand, this third claim is now limited to the application of the commutator subsequent upon an insulating hub. It permits of those segments being otherwise located if desired in any case. In the above respects the third claim differs from the second claim because the second claim includes the insulating hub as an element of the combination. Again the second claim does not treat of the commutator segments in the abstract, but considers them in electrical connection with the dynamo, while the third claim covers the peculiar combination of sub-segments, wearing segments, and screws, simply as a definite mechanical structure, nor yet necessarily in electrical or mechanical connection with a dynamo, but adapted for use in a dynamo. And, finally, the second claim does not definitely particularise that the sub-segments and wearing segments shall be united together by "screws, K," as the third claim does, but permits these segments to be joined in any other way that will allow of their detachable attachment to each other for carrying out the spirit and intent of the fundamental invention. For instance, the sub-segments and wearing segments might be joined by a dovetailed or tongue and groove construction, so that the wearing segments could be slid on or off from their respective sub-segments. This and other modified ways of detachably uniting the segments is permitted by the terms of the second claim, as I understand it, while such is not the case with the third claim, which specifies the "screws, K," as the means for uniting these segments.

Is the subject matter of the third claim described or indicated in the provisional specification? If so, explain where and how, and in particular where and how the "screws, K" are described or indicated in the provisional specification?—I have already answered this question. As regards the "screws, K," in particular, while they are not specifically denominated in the language of the provisional specification, it seems to me that they or their substantial equivalent are clearly and certainly indicated. In fact, they or their equivalent are so necessarily involved in the language of the specification, that it would appear prolix to go into a more detailed description than has been done. The provisional specification says, "And wearing segments detachably attached to said sub-segments." The common and generally-accepted understanding of the term "detachably attached" is an union or attachment that can readily and conveniently be severed without rupture or disintegration. The provisional specification requires the sub-segments and the wearing segments to be united.

What is the purpose or object desired to be secured by the segments, T, in the fourth claim?—The segments, T, operate to so break and open the circuit of their associate armature bobbins, that those bobbins shall be open circuited, while they are passing through the neutral or current-reversing points of the field of the dynamo.

Is the purpose or object of them the same as that of the detachable segments?—With the understanding that by detachable segments in the question is meant the "conducting segments, S," of the Haddan patent, I answer "No." It must not be overlooked, however, that the insulating segments, T, as illustrated in drawings of the Haddan patent and described in the specification are detachably attached to corresponding sub-segments, and although acting as insulating segments in relation to some of the armature bobbins, are at the same time electrically attached to adjoining conducting segments, S, and are thus electrically connected with armature bobbins other than those for which they act as circuit openers.

Does the commutator referred to in said fourth claim refer to a commuator with sub-segments, with wearing segments detachably attached?—Not necessarily. The fourth claim is intended to cover a commutator "having metallic insulating segments, T," for cutting armature bobbins out of circuit when said bobbins are traversing the neutral or current-reversing points of the field, whether these segments, T, are detachably attached to sub-segmets or not.

Is the subject matter of the fourth claim indicated in the provisional specification? If you answer "Yes," point out where and explain your answer, and in particular point out where the segments, T, are referred to or indicated in the provisional specification.—It is in a following passage beginning in line 11 of the provisional specification: "Also in constructing commutators cylindrical with insulating hub or body, to which are attached metallic sub-segments placed in electrical connection with the general mechanism in which the commutator is employed and metallic wearing segments detachably attached to said sub-segments." I have already explained that the wearing segments, T, are "in electrical connection with the general mechanism with which the commutator is employed."

State wherein the novelty of the subject matter of claim 4 consists.—The novelty of the subject-matter of claim 4 consists in providing a dynamo commutator with segments having the following characteristic and function. They are metallic, like the electro-conducting segments of the commutator, thus forming a wearing surface corresponding to the general wearing surface of the rest of the commutator, whereby, as the Haddan patent states, "I ensure a uniformity of wear over the entire face of the commutator." An insulating segment, T, as I have already explained, operates to cut out of circuit a pair of armature bobbins while they are passing through the neutral or current-reversing point of the field. This is its peculiar function.

(*To be continued.*)

NEW PATENTS—1889.

2375. "Improvements in the construction of telephones." S. B. WILKINS. Dated February 11.

2407. "Improvements in dynamo-electric machines." A. BERNSTEIN. Dated February 11. (*Complete.*)

2413. "Improvements in printing telegraphs." J. E. WRIGHT and J. MOORE. Dated February 11.

2472. "Improvements in secondary batteries, and plates or elements therefor." W. L. Wise. (Communicated by the Gibson Electric Company of Europe, France.) Dated February 12.

2476. "An improved electrical alarm." S. Sudworth. Dated February 12.

2480. "Improvements in and relating to apparatus for measuring electric currents." H. H. Lake. (Communicated by H. H. Cutler, United States. Dated February 12. (*Complete.*)

2536. "Lighting cigars, pipes, &c., by electricity." T. W. Watson and A. H. Watson. Dated February 13.

2544. "Improvements in the form and manufacture of secondary battery frames and plates. A. Douglass and F. Smith. Dated February 13.

2567. "Improved means and apparatus for electrically driving vehicles." P. B. Elwell and J. K. Starley. Dated February 13.

2614. "Improvements in electric meters." J. Oulton and J. Edmondson. Dated February 14.

2628. "Improvements in electric contact and alarm thermometers." M. Stuhl, J. M. Lautenschlager and F. Lautenschlager. Dated February 14. (*Complete.*)

2642. "Improvements in dynamo-electric machines." G. Forbes. Dated February 14.

2646. "Improvements in apparatus or means for metering electric currents." W. H. Scott and Laurence, Paris and Scott. Dated February 14.

2674. "Apparatus for signalling in mines and coal pits, and on railways and elsewhere, and for stopping the winding or hauling steam engines when such signals are given, and for causing intermittent currents of electricity or magnetism for any required purpose." H. J. Peddie. Dated February 15.

2694. "Improvements in apparatus for the measurement of electrical resistances." W. T. Goolden and S. Evershed. Dated February 15.

2742. "Improvements in automatic switches for suspended 'arc' lamps." F. Wagg and W. Hudson. Dated February 16.

2748. "Improvements in telephonic switching apparatus." A. R. Bennett. Dated February 16. (*Complete.*)

2854. "Improvements in electric light fittings." D. Urquhart and W. Bates. Dated February 18.

2885. "Improvements in methods and apparatus for charging secondary batteries or electrical accumulators." R. H. C. Nevile. Dated February 19.

2906. "Improvements in microtelephonic apparatus, which improvements consist partly in the use and employment of fluids as a medium to impart vibratory motion by means of sound, and currents of electricity." R. H. Courtenay. Dated February 19.

2943. "Improvements in dynamo-electric machines." S. D. Williams. Dated February 19.

2949. "Improvements in galvanic batteries." E. D. Cross. Dated February 19. (*Complete.*)

2952. "Improvements relating to the transmission of electromagnetic impulses for telegraphic and other purposes." H. H. Lake. (Communicated by C. E. Dressler, United States.) Dated February 19. (*Complete.*)

2957. "Improvements in underground conduits and insulators for electrical mains." A. Wilson and L. Clark, Muirhead and Co., Limited. Dated February 19.

3022. "An improved telephone mouth-piece." R. Cotterell. Dated February 20.

3036. "Improvements in electric signalling apparatus for railway trains." A. J. Boult. (Communicated by W. C. Johnston, Jun., United States.) Dated February 20. (*Complete.*)

3069. "Electrical signalling, self-acting, and otherwise, on a railway." G. Prince and J. Watkinson. Dated February 21.

3108. "Improvements in electrical measuring instruments." W. Hibbert. Dated February 21.

3130. "Improvements in or connected with gear wheels and bearings for magneto-electric call-bell apparatus for telephonic instruments, applicable also to other mechanism. H. Fraser. Dated February 21.

3163. "Improvements in electrical call-box apparatus." F. T. Schmidt. Dated February 22.

3213. "Improvements in measuring instruments and electrical appliances." W. E. Ayrton and J. Perry. Dated February 22.

3272. "Improvements in or relating to electric motors. W. P. Thompson. (Communicated by the Westinghouse Electric Company, United States.) Dated February 23.

3273. "Improvements in or relating to dynamo-electric generators." W. P. Thompson. (Communicated by the Westinghouse Electric Company, United States.) Dated February 23.

ABSTRACTS
OF PUBLISHED SPECIFICATIONS, 1888.

11065. "Improvements in or relating to apparatus for supplying variable amounts of electricity to and thus regulating the brilliancy of electric lamps." W. P. Thompson. (A communication from abroad by G. Westinghouse, jun., of Pittsburgh.) Dated July 31. 6d. Caims:—1. The combination with a source of alternating, intermittent, or pulsatory electric current, of a single coil of insulated wire included in circuit with said source, translating devices, a circuit including the latter in series with a portion only of said coil, and a single core at all times entirely within the inductive influence of said coil, but movable therein with reference to the last-named circuit, whereby the brilliancy of the lights may be regulated. 2. The combination of a source of electric currents, a coil of insulated wire included in its circuit, translating devices included in series with a portion of the coil, and in multiple arc with another portion of the coil, and a core movable within said coil.

11681. "Improvements relating to electric batteries and to exciting liquids or compounds therefor." C. E. Liebert and S. A. Rosenthal. Dated August 13. 6d. Claims:—1. In an electric battery the employment of a silvered non-conductor in lieu of a silver plate as an electrode. 2. An exciting liquid for silver and zinc batteries consisting of 100 parts by weight of water, from 12 to 20 parts of sulphate of zinc, from 1 to 4 parts of sulphuric acid, and from 2 to 10 parts of perchloride of mercury or protochloride of mercury. 3. For the purpose of converting the said exciting liquid into a dry state, the thickening of the same by tragacanth or other mucilaginous substances.

1383. "Electric apparatus for use either as an electro-motor or as an electric current meter." F. Borel and E. Paccaud. Dated January 30. 11d. Consists essentially in the combination of two electro-magnets, one of which is fixed, whilst the other has a fixed solenoid, but a rotative core. The claims are 6 in number.

14981. "Improved method of and apparatus for actuating printing machinery by means of an electric current, and instantaneously checking or arresting the motion thereof when required." R. R. Hutchinson. Dated October 18. 8d. Claims:—1. The combination of a lithographic, letter press, or other printing machine with an electric motor, for the purpose of applying electricity to said machine as a motive power, substantially as described and shown. 2. In a combination of an electric motor and a printing machine as referred to in the preceding claim, the employment of an electric brake, with a regulating appliance, substantially as described and shown. 3. The combination of an electric motor, an electro-magnetic brake or brakes, and regulating switch, with a lithographic, letter press, or other printing machine, substantially as and for the purposes described and shown in the drawings.

CORRESPONDENCE.

The Barnet Installation.

Having had my attention drawn to your remarks about myself in your last week's paper, I am surprised that you should criticise a perfect stranger in the way you do, without taking proper means to ascertain the true facts, or should quote at such length from a paper like the *Barnet Press*, which reports nothing but what is in favour of the gas, and also seeing that in the same issue they accuse your paper of gross misrepresentation. Would space permit, I could furnish you with many of my own statements that have received similar treatment at their hands. As regards the electric lighting of Barnet, I have supported it for what I believe to be the best interests of our town. We have had a gas monopoly for many years, and the dissatisfaction with the gas company has been so great that many residents, in both private houses and shops, have returned to the use of oil lamps rather than use the gas. I have contested the Gas Company Acts successfully in Parliament for two years as the representative of the town and the oldest member of the Local Board, and although we have done our best to obtain good gas at a fair price, we paid when I first came to Barnet, 36 years ago, 9s. per 1,000 feet; we reduced it to 5s., then to 4s. 6d. per 1,000 feet for inferior gas. These, and other grievances against the gas company, have caused us to invite contractors to come and fit the electric light, and after waiting some years we gladly welcomed Mr. Joel; myself, in common with many others in the town, have done our best to support and encourage him. I unhesitatingly say that so far the lighting has been a great success, and it is constantly improving. It is my firm belief, and I think that you will agree with me, that if Mr. Joel can light our town so well with his present machinery, with the new duplicate machinery now about to be put down the lighting will be all that can be desired, and most people will have it in their houses. Since Mr. Joel has taken us in hand, the gas has been reduced 6d. per 1,000 feet, and it certainly is of better quality than before. The gentlemen whom you specially commend for objecting to the electric light are well-known to be gas shareholders; they have opposed electric lighting in every way, and your criticism of Mr. Joel will do more to help them and the gas company than the gas journals are doing. Indeed, I am amazed that you, as an electrical journal, should speak as you do. I should have thought you would have been fair to your own profession, and not have tried to hold us up to ridicule for doing our best to have the advantages of the new light.

D. Schmidt.

March 6th, 1889.

[We are pleased to insert this letter, but Mr. Schmidt must surely be aware that our remarks anent himself were called for by his own public utterances. Even the *Barnet Press* cannot report speeches which are not delivered, and as for its misrepresentation of our comments, we cannot hold ourselves responsible for its mistake, which we endeavoured to set right in our last. That we should speak as we have done will amaze no one but our correspondent; and even he should know that it is best for the electrical world at large to be made fully aware of such failures as those at Barnet to prevent a repetition elsewhere.—EDS. ELEC. REV.]

Problems and Conditions of Ocean Telegraphy.

I should like to make one or two observations on your leader entitled "Problems and Conditions of Ocean Telegraphy." As an old friend of one of the gentlemen who have been instrumental in bringing hemp-covered cables to the front again, I note certain passages which convey to my mind erroneous impressions.

The hemp-covered cable in Halifax Harbour is, I am informed, not on a mud bottom, and I am told, also, that the waters are infested with the teredo which, according to practice, should have long since destroyed its life.

The method of recovering a cable by drifting across it till the strain on the dynamometer tells that something is on the grapnel is at least rough and uncertain, and is less likely to be successful as the cable becomes older; in evidence, there are the defunct Atlantic cables.

There is no doubt that a ship, when dragging for an old and rusty cable, often goes through it unknown to those on board, and it is only when a drift is made some miles away in a sounder part that the strength of the cable can bear the strain and show it on the dynamometer.

This is not a satisfactory state of things for cable companies who own old cables, and it has naturally been left to those who have to do with repairs of the old more than with the laying of new cables to discover a more sensitive device than the dynamometer for indicating the hooking of a cable.

The grapnel that has been used with this intent has done good service in deep water, and it indicates the fact that the cable is caught immediately it has settled between the prongs.

Such a grapnel would probably be used in the recovery of hempen cables, so that the picture that is drawn in the article in question of the destruction of the hemp by the reason of the grapnel surging along the cable does not apply, and it is, moreover, a little behind the time. I believe it was never contemplated by its experienced inventors to bring the unarmoured cable either as an intermediate or shore end into the cable hut.

I should say that there is still room for improvement in cable work, and while we should not condemn a serviceable article, we should be alive to investigate the merits of a rival.

As regards the non-corrosion of iron-clad, or the lasting qualities of hemp-covered cables, I do not doubt that evidence could be brought in support of and against each. An authoritative investigation into this part of the subject would be of essential service and aid to a settlement as to which is the best type of marine cable—the armoured or unarmoured.

E. W. Becking

February 27th, 1889.

Nothing New Under the Sun.

I notice in your journal, dated the 11th January description of "Gilbert's Patent Shackle Ball I lator," and beg to point out, as an illustration of adage that there is nothing new under the sun, th precisely similar article was in use in India some years ago.

They were known as "testing balls" or "earth ware circuit breakers," and were introduced by Li Shepherd, R.E., then in the Telegraph Department, afford a means of interrupting the circuit, with cutting the line wire, for testing purposes, or for serting the wires leading into an office. They illustrated in the accompanying sketch, which is co from the standard diagrams of the Department. T is a sample of the article, known as pattern No. 3, deposited at the India Store Depôt, London, with usual specification.

Mr. Gilbert's method of using these insulators di from ours, but the idea is precisely the same. They still in use in India, but not to any large extent, ow to their low insulation.

P. V. Luke,
Officiating Director, Indian Telegraph
Construction Branch.

Calcutta, *February 12th*, 1889.

[We are much indebted to Mr. Luke for such an teresting account of the doings in India so many y ago.—EDS. ELEC. REV.]

The Life of Accumulators.

Re your comment on M. Emile Reynier's work "The Voltaic Accumulator," it may perhaps be teresting to note to some of your readers a few act facts *re* the "Reynier cells." I was working on Continent a short time ago installing a set of 56 Engli cells in place of 60 Reynier cells, and I had gr trouble in persuading the driver that the life of English positives was, with careful usage, practical unlimited. This can be easily understood when knows that he used on the average to renew 12 po tives per week and to press about 15 per day.

The cells were not discharged too rapidly, as wh coupled up in one series of 60 they lighted 22 lamps 50 watts, and each cell consisted of, I think, 13 pla about 7 by 5 inches.

This shows that M. Reynier's average of renewals 20 to 100 per cent. is not in any way exorbitant.

Wallace J. L. Sandy.

March 2nd, 1889.

Incandescent Lamps in Series.

Barnet from time to time has caused much comm through failures of Messrs. Joel's system of inca descent lighting.

I beg to ask if there is any known system of inca descent lighting joined in series giving satisfaction. some six years ago joined a number of 10 candle-pow lamps in series; the result was about 4 candle-pow per each lamp. I joined the same in bridge, and th full candle-power was obtained.

W. A. Denman.

March 4th, 1889.

[We believe that in America the Heisler system using incandescent lamps in series has achieved som degree of success, but it is possible that in some of th smaller towns in the States even such failures as tho which have made Barnet the centre of observation electric lighting circles here might be tolerated, esp cially as in many instances there is no gas to fall b upon.—EDS. ELEC. REV.]